California Regional Water Quality Control Board
Los Angeles Region

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.waterboards.ca.gov/losangeles

Linda S. Adams
Agency Secretary

Arnold Schwarzenegger
Governor

August 6, 2009

Gerald W. Bowes, Ph.D.
Manager, Cal/EPA Scientific Peer Review Program
Office of Research, Planning and Performance
State Water Resources Control Board
1001 I Street, Sacramento, CA 95814

SUBJECT: Request for External Peer Review of Technical Memoranda #3 and #4 in support of an amendment to the *Water Quality Control Plan for Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan)* to Prohibit On-Site Subsurface Disposal Systems – Malibu Civic Center Area

Dear Dr. Bowes:

Pursuant to the *California Health and Safety Code,* section 57004, amendments to basin plans are subject to peer review. We are hereby requesting external peer review of two technical memoranda (tech memos) that were prepared by Regional Water Quality Control Board for the Los Angeles Region in support of a proposed amendment to the *Basin Plan* to prohibit discharges from on-site wastewater disposal systems (OWDSs) in the Malibu Civic Center area. These tech memos are:

Technical Memorandum #3: **Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment to Water Contact Recreation**, by Elizabeth Erickson, P.G.

Technical Memorandum #4: **Nitrogen Loads in Wastewaters flowing to Malibu Lagoon Are a Significant Source of Impairment to Aquatic Life**, by Toni Calloway, P.G, Orlando Gonzalez, and Dr. C.P Lai, P.E.

Drafts of the above two tech memos are available for peer review and are included in attachment 4. For background, we have included, also in attachment 4, our overview[1] of all five technical memoranda that comprise the evidence supporting our proposed prohibition (*Basin Plan*

[1] Please note that this overview includes a summary of all five tech memos. As this extra material is provided as background, we ask that you limit the peer review to tech memos #3 and #4 (which are included in attachment 4, following the overview). Also, it is important to note that we are not requesting peer review of the TMDLs (Total Maximum Daily Loads) that are related to this proposed prohibition, as these TMDLs have already been peer reviewed, or modeled on TMDLs that had already received peer review(s).

amendment). You may also read and download these documents, along with other documents related to this regulatory action, at http://www.waterboards.ca.gov/losangeles/press_room/announcements/Public Hearing-Malibu/index.shtml.

A 'plain English' version, along with our proposed Basin Plan amendment language (in a draft resolution, proposed for adoption on October 1, 2009), is included as attachment 1. A description of scientific issues to be addressed is included as attachment 2. A list of Regional Board staff who participated in the development of tech memos #3 and #4 is included in attachment 3.

As we have scheduled this proposed regulatory action for public hearing on October 1, 2009, we hope that you will be able to accommodate our request to expedite the review of tech memos #3 and #4, and complete this effort by September 3, 2009. Should you have any questions regarding these studies and the development of the proposed prohibition, please contact me at (213) 576-6618 or wphillips@waterboards.ca.gov.

Sincerely,

Wendy Phillips
Chief, Groundwater Permitting and Landfills Section

cc: Rik Rasmussen, State Water Resources Control Board
Jeff Ogata, State Water Resources Control Board
Todd Thompson, State Water Resources Control Board
Tracy Egoscue, Los Angeles Regional Water Quality Control Board
Deborah Smith, Los Angeles Regional Water Quality Control Board

Attachments:

1. 'Plain English' summary of the *Basin Plan* amendment

2. Scientific Issues to be addressed by peer review for Technical Memoranda #3 and #4 of the proposed Prohibition on On-Site Wastewater Disposal Systems (OWDSs), drafts dated July 31, 2009 and August 5, 2009 respectively.

3. List of Participants in Tech Memos #3 and #4.

4. Technical Staff Report (Overview – draft dated July 31, 2009), in support of an Amendment to the *Water Quality Control Plan for Coastal Watersheds of Los Angeles and Ventura Counties* to Prohibit On-Site Wastewater Disposal Systems in the Malibu Civic Center Area, plus Tech Memos #3 and #4 – draft dated July 31, 2009. [2]

    a. Technical Memorandum #3: **Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment to Water Contact Recreation**, by Elizabeth Erickson, P.G. – draft dated July 31, 2009.

    b. Technical Memorandum #4: **Nitrogen Loads in Wastewaters flowing to Malibu Lagoon Are a Significant Source of Impairment to Aquatic Life**, by Toni Calloway, P.G, Orlando Gonzalez, and Dr. C.P Lai, P.E. – draft dated August 5, 2009.

[2] Other tech memos and materials related to this proposed regulatory action, may be accessed and downloaded at http://www.waterboards.ca.gov/losangeles/press_room/announcements/Public Hearing-Malibu/index.shtml.

Attachment 1
'Plain English' Summary of the *Basin Plan* Amendment

Draft Technical Staff Report *(dated July 31, 2009)*

Evidence in support of an Amendment to the Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties to incorporate a Prohibition on On-site Wastewater Disposal Systems in the Malibu Civic Center Area

Introduction

Staff at the Regional Water Quality Control Board (Regional Board) has presented evidence in support of a prohibition on subsurface disposal systems in the Malibu Civic Center area. The Malibu Civic Center area (shown in Figure 1 of attachment 4) includes Malibu Valley, Winter Canyon, and the adjacent coastal strips of land and beaches. Types of subsurface disposal systems that would be prohibited range from passive systems with conventional septic tanks to active systems that more aggressively remove pollutant loads from sewage before subsurface disposal. The prohibition would apply to systems that serve individual properties (residential, commercial, industrial, and public properties) as well as groups of those properties. Collectively throughout this report, these disposal systems are referred to as on-site wastewater disposal systems, or OWDSs.

The prohibition would be in the form of an amendment to the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan).* To effect the amendment, staff is proposing that the board adopt the attached resolution, at a public hearing scheduled for October 1, 2009.

Background

The Malibu Civic Center area supports a population of about 1,000 residents and is the core of the City's business, cultural, and commercial activities. The area, which includes the renowned Surfrider Beach, attracts a high volume of visitors.

Without community sewers and wastewater treatment infrastructure, residents, businesses, and public facilities in the City of Malibu use thousands of on-site disposal systems to discharge their sewage to the subsurface and underlying groundwater. In several areas of the City, unfavorable hydrogeologic conditions coupled with high flows of wastewaters have raised concerns about reliance on this wastewater disposal strategy. In one of those areas of concern, the Malibu Civic Center area, intensive land use activities by almost 400 dischargers result in the release of wastewaters to the subsurface at a rate that Regional Board staff estimates to be as high as 255,000 gallons per day (gpd).

In a series of tech memos, staff presents evidence showing that OWDSs in the area have released pollutants that impair the beneficial uses of the following water resources:

- Malibu Lagoon – a valuable fresh/saltwater habitat for rare, threatened and endangered species. Nitrogen loads from OWDSs, transported in groundwater that recharges the lagoon, accelerates eutrophication (a process that depletes oxygen dissolved in water and stimulates aquatic growth – i.e. the formation of excessive amounts of algae).

- Malibu Civic Center area beaches – Together with Malibu Lagoon and Malibu Creek, the beaches along the Civic Center area are popular among residents for contact (e.g. sun-bathing, bird-watching, hiking, picnicking) and non-contact recreation (e.g. swimming, surfing, wading). They are also a destination for visitors. However, due, in part, to pathogens released from OWDSs, these waters consistently fail to meet public health standards for water contact recreation, and the renowned Surfrider Beach has a 'beach bummer' reputation among surfers and the media.

- Groundwater – Although groundwater in the area is not an existing source of drinking water to the community, groundwater was the community's source of drinking water until the 1960s. Groundwater production in the area gradually ceased as a newly formed special district – Los Angeles County Waterworks District No. 29, Malibu – started delivering imported water to the area in the early 1960s. As a future resource – and also in the event of a disruption of deliveries of imported water, groundwater is an important local resource that the community may need to use in the future. The Regional Board recognized this beneficial use, in designating groundwater as a potential source of drinking water in the *Basin Plan*. However, pathogens released to groundwater from OWDSs impair the use of potential use of groundwater as a source of drinking water.

TMDLs

In order to restore beneficial uses, the Regional Board and/or US Environmental Protection Agency, has taken past actions, through *Basin Plan* amendments, to establish Total Maximum Daily Loads (TMDLs), including:

a. **Malibu Creek Watershed Nutrient TMDL:** The US EPA, on March 21, 2003, specified a numeric target of 1.0 mg/l for total nitrogen during summer months (April 15 to November 15) and a numeric target of 8.0 mg/L for total nitrogen during winter months (November 16 to April 14). Significant sources of the nutrient pollutants include discharges of wastewaters from commercial, public, and residential landuse activities.

The TMDL specifies a load allocation for on-site wastewater disposal systems of 6 lbs/day during the summer months and 8 mg/L during winter months.

b. **Malibu Creek and Lagoon Bacteria TMDL:** The Regional Board specified numeric targets, effective January 24, 2006, based on single sample and geometric mean bacteria water quality objectives in the *Basin Plan* to protect the water contact recreation use. Sources of bacteria loading include storm water runoff, dry-weather runoff, on-site wastewater disposal systems, and animal wastes. The TMDL specifies load allocations for on-site wastewater disposal systems[2] equal to the allowable number of exceedance days of the numeric targets. There are no allowable exceedance days of the geometric mean numeric targets. For the single sample numeric targets, based on daily sampling, in summer (April 1 to October 31), there are no allowable exceedance days, in winter dry weather (November 1 to March 31), there are three allowable exceedances days, and in wet weather (defined as days with >=0.1 and the three days following the rain event), there are 17 allowable exceedance days.

c. **Santa Monica Bay Beaches Wet and Dry Bacteria TMDL:** For beaches along the Santa Monica Bay impaired by bacteria in dry and wet weather, the Regional Board specified numeric targets, effective July 15, 2003, based on the single sample and geometric mean bacteria water quality objectives in the *Basin Plan* to protect the water contact recreation use. The dry weather TMDL identified the sources of bacteria loading as dry-weather urban runoff, natural source runoff and groundwater. The wet weather TMDL identified stormwater runoff as a major source. The TMDLs did not provide load allocations for on-site wastewater disposal systems, meaning that no exceedances of the numeric targets are permissible as a result of discharges from non-point sources, including on-site wastewater disposal systems. There are no allowable exceedance days of the geometric mean numeric targets. For the single sample numeric targets, based on daily sampling, in summer (April 1 to October 31), there are no allowable exceedance days, in winter dry weather (November 1 to March 31), there are three allowable exceedances days, and in wet weather (defined as days with >=0.1 and the three days following the rain event), there are 17 allowable exceedance days.

These TMDLs completed peer review prior to adoption, or were closely modeled on TMDLs that had already completed the peer review process.

<u>Summary of Evidence in support of the Prohibition</u>

Staff investigations focused in five areas and are presented in five technical memoranda that comprise this staff report and that meet the requirements of the California Water Code, sections 13280 and 13281 for determination that discharges of OWDSs in the Malibu Civic Center area result in violation of water quality objectives, will impair present or future beneficial uses of water, will cause pollution, nuisance, or contamination, or will unreasonably degrade the quality of any water of the state.

Technical Memorandum #1: Permitted Dischargers Have Poor Records of Compliance with Regional Board Orders.

For the privilege of discharging wastewater to a water of the state (including both surface water and groundwater), dischargers must comply with waste discharge requirements (WDRs) that are specified in Orders issued by the Regional Board. The WDRs generally incorporate monitoring and reporting programs that rely on self-monitoring by dischargers. The reports of self-monitoring are used by the Regional Board to determine compliance and to ensure that the quality of the water into which wastes are discharged is not degraded and that beneficial uses, such as drinking water and swimming (body contact recreation) are protected.

In the Malibu Civic Center area, the Regional Board regulates 21 discharges, all of which are from commercial, industrial, or public facilities. In a review of the compliance records for these discharges, each discharger had a record of violations. Among the most serious violations are repeated failures to achieve effluent limits specified in WDRs; in particular, limits for pathogens and nutrients (species of nitrogen and phosphorus) that are identified as pollutants in nearby waters that the Regional Board and EPA have designated as impaired under Clean Water Act section 303(d). Also, several dischargers 'failed to submit' monitoring reports, and compliance with technical requirements in their WDRs could not be determined.

Staff concludes that dischargers have poor records of compliance with Orders issued by Regional Board, and that discharges are, in general, not meeting requirements prescribed to protect water quality and beneficial uses.

Technical Memorandum #2: Pathogens and Nitrogen in Wastewaters Impair Underlying Groundwater as a Potential Source of Drinking Water.

To evaluate impacts from OWDSs on groundwater as a potential source of drinking water, staff identified 47 groundwater wells, all of which were designed and constructed for monitoring the quality of groundwater, and compiled data pathogens and nitrogen. To examine the extent of impairment of this groundwater for drinking water, staff compiled all available analytical results of sampling for pathogen indicators and nitrogen species during the period July 2002 through May 2009 and compared these results with drinking water standards for these pollutants. As summarized in graphs and tables for each well:

- ***Pathogens in Groundwater do not meet the Drinking Water Standard:*** Forty-four wells, or 94% of the 47 wells, had fecal coliform during at least one sampling period. Of the 671 fecal coliform samples collected from the 47 wells during the review period, 360 samples (54%) tested positive and exceeded the maximum contaminant level (MCL) of less than 1.1 MPN/100ml (Most Probable Number per 100 milliliters).

- ***Nitrogen in Groundwater does not meet the Drinking Water Standard:*** Fourteen wells, or 30% of the 47 wells, had nitrate plus nitrite at levels above the MCL of 10 mg/L (as nitrogen). Of the 671 samples collected from the 47 wells during the review period, 100 (15%) were above the MCL. Although there is no drinking water standard for ammonia, staff also reviewed analytical data for ammonia in view of the likelihood that the ammonia species of nitrogen will nitrify. These results indicate that, when concentrations of ammonia (converted to nitrogen) are added to concentrations of nitrate and nitrite, 163 samples or 24% were above the MCL. Twenty-four wells, or 51% of the 47 wells, had levels above the MCL of 10 mg/L.

As indicated by coliform results, pathogens are present in groundwater at levels that elevate the risk of infectious disease should this groundwater be used for potable purposes. As indicated by the nitrogen results, species of nitrogen are present in groundwater at levels that can cause health problems in humans should this groundwater be used for potable purposes. Infants and fetuses are particularly sensitive and can develop methemoglobinemia (blue-baby syndrome) from ingestion of water with nitrate at levels that deplete oxygen in the blood stream.

Technical Memorandum #3: Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment to Water Contact Recreation.

To examine the hydraulic connection of discharges from OWDSs through groundwater to nearby surface waters, staff evaluated more than 8,000 samples of wastewater effluent, underlying or nearby groundwater, and surface waters. Staff determined that pathogens from wastewaters migrate to surface waters and that, consistent with data supporting the designations of impairments, the levels of pathogens do not meet standards protective of human health. Staff also determined that risks of infectious disease from water contact recreation were elevated at beaches in the Malibu Civic Center area versus comparable beaches with sewers.

Staff also reviewed numerous previous studies, and found conclusions from these other studies to be consistent with staff's determination of impairment to beneficial use of water contact recreation.

Technical Memorandum #4: Nitrogen Loads in Wastewaters flowing to Malibu Lagoon Are a Significant Source of Impairment to Aquatic Life.

As noted above, beneficial uses of Malibu Lagoon are impaired by excessive nutrient levels in the lagoon, depleting dissolved oxygen in the water and stimulating aquatic growth (algae). As established in the nutrient TMDL, nitrogen from OWDSs in hydraulic connection with the lagoon are subject to a load allocation of six pounds per day.

To quantify current nitrogen loads from OWDSs in the Malibu Civic Center area to the lagoon, staff compiled an inventory of 38 commercial dischargers and 349 residential dischargers. Using real data where available and reasonable assumptions (based on published literature and best professional judgment) for data gaps, staff calculated that the dischargers release about 255,000 gpd through OWDSs and estimated nitrogen loading factors. Applying these nitrogen loading factors to update an existing numerical model designed and calibrated by Questa 2005 for an earlier investigation, staff estimates that nitrogen loads released from OWDSs and transmitted via groundwaters to Malibu Lagoon total 29 pounds per day (lb/day). As a check, staff used the same flows and loading factors to a 'spreadsheet' model which characterized wastewater transport by hydrogeologic sector. Based on the 'spreadsheet' model, staff estimates that wastewaters transport 36 lb/day into Malibu Lagoon.

Staff's estimates of 29 lb/day to 36 lb/day from the numeric and 'spreadsheet' models are greater than two of the estimates (17 lb/day to 20 lb/day) prepared by the third parties in previous studies, and slightly overlap the estimate by the other third party (32 lb/day). Among the factors accounting for the range in estimates between staff's estimates and third-party estimates are:

- Commercial Flows: The third-party models used significantly lower assumptions for commercial wastewater flows.
- Nitrogen Concentrations – Residential: Two of the three third-party models assumed that residential wastewaters have nitrogen concentrations that are about one-half of what staff determined is a reasonable assumption.
- Nitrogen Concentration – Commercial: Staff determined that the average nitrogen concentration of commercial wastewater discharges has decreased since 2004, as OWTSs with greater treatment capabilities has been brought on-line. However, this declining trend in this subset of OWTSs is not great enough to meet the TMDL goal.

Regardless of differing assumptions and models used in the estimates, all estimates – including those prepared by staff as well as past estimates prepared by third parties – indicate that nitrogen loads from OWDSs are significantly above the load allocation of 6 lb/day for OWDSs established in a TMDL. Accordingly, staff concludes that OWDSs in the Malibu Civic Center area cumulatively release nitrogen at rates that contribute to eutrophication and impair aquatic life in Malibu Lagoon. This conclusion is supported by staff's estimates ranging from 29 lb/day to 36 lb/day as wells as third-party estimates from 17 lb/day to 32 lb/day, all of which fail to meet targets established to restore water quality and protect beneficial uses in Malibu Lagoon.

Technical Memorandum No. 5: Dischargers with Unsuitable Hydrogeologic Conditions for High Flows of Wastewaters Resort to Hauling Liquid Sewage and Sludge to Communities that have Sewer and Wastewater Treatment Facilities.

Intensive land use activities on many properties in the Malibu Civic Center area generate wastewater flows at rates that exceed the capacity of OWDSs to transmit the wastewaters into the subsurface. While some dischargers are limited by treatment equipment that has inadequate capacity and/or treatment capabilities, many dischargers do not have adequate disposal capacity on their properties to transmit the wastewaters into the subsurface. Their disposal rates can be constrained not only by lack of space, or area, for on-site disposal fields, but by hydrogeologic constraints as well, such as a high water table or tight soils. Consequently, in order to avoid failure of the OWDSs, a significant number of large dischargers resort to hauling liquid sewage and sludge to communities that have infrastructure to accept their liquid wastes.

To quantify reliance on the practice of hauling, staff reviewed reports of self-monitoring, which include summaries of off-site hauling, submitted by ten large commercial dischargers. In 2008, these ten dischargers, whose activities generated a total of approximately 28 million gallons of wastewater (77,000 gpd), hauled almost 2 million gallons (5,500 gpd), or about 7%, of their raw sewage to off-site disposal facilities. Furthermore, staff quantified trends from 2004 through 2008, which indicate that these ten dischargers have cumulatively increased their rate of wastewater generation by 15% and their rate of hauling by 29%. (Staff was not unable use existing data from dischargers to analyze seasonal hauling trends – e.g. hauling trends during the wet season, and also during warm summer holidays when populations have high peaks.)

<u>Recommendation</u>

Based on the evidence above, staff has proposed action by the Regional Board that will immediately halt new discharges of wastewater in the Malibu Civic Center area, and mandate a five-year time schedule for existing dischargers to cease, during which time the city, or an existing or newly formed utility or water authority would construct a regional compliance project to meet the five-year time schedule (see the Environmental Staff Report for details).

The resolution setting forth these actions, including the language for the proposed amendment to the *Basin Plan*, is attached. Critical portions are re-stated below:

> *This action was supported by technical evidence that concluded:*
>
> *i. Dischargers subject to Orders from the Regional Board that specify waste discharge requirements (WDRs) for OWDSs have poor records of compliance.*

ii. *Discharges of wastewaters released from OWDSs to groundwater contain elevated levels of pathogens and nitrogen that impair underlying groundwater as a potential source of drinking water.*

iii. *Discharges of wastewaters released from OWDSs to groundwater that is in hydraulic connection with beaches along the mouths of unsewered watersheds transport pathogens that elevate risks of infectious disease for water contact recreation.*

iv. *Discharges of wastewaters released from OWDSs to groundwater that is in hydraulic connection with Malibu Lagoon transport a nitrogen load significantly in excess of the wasteload allocation in the TMDL established to restore water quality to a level sufficient to protect aquatic life and prevent nuisance resulting from eutrophication.*

v. *Wastewater flows in the Civic Center area have been increasing. On many sites, hydrogeologic conditions are unsuitable for high flows of wastewater, and many dischargers generate wastewater flows at rates that exceed their capacity to discharge on-site. These dischargers rely on pumping significant flows into tanker trucks that haul liquid sewage and sludge via public roadways to communities that have sewer and wastewater treatment facilities.*

[Re Time Schedule]
….the City is hereby directed to submit quarterly written reports to the Executive Officer, summarizing the strategy and progress toward meeting the five-year prohibition deadline. In the quarterly progress reports, the City shall document progress, to the satisfaction of the Executive Officer, toward the following interim and final deadlines:

April 1, 2010: Completion of 25% of a master facilities plan for possible projects to comply with the prohibition, including initiation of a strong public participation program.

October 1, 2010: Completion of 50% of a master facilities plan and initiation of environmental review, with strong, on-going public participation. Concurrently, initiation of preliminary engineering and a feasibility study for possible projects to comply with the prohibition.

April 1, 2011: Substantial completion of a master facilities plan, preliminary engineering and a feasibility study, and engagement of the public in selection of a project to comply with the prohibition.

October 1, 2011: Completion of a master facilities plan, preliminary engineering and a feasibility study, and selection of a project to comply with the prohibition.

October 1, 2012: Completion of final design for selected project.

October 1, 2013: Completion of 50% of construction of selected project.

October 1, 2014: Completion of project to comply with prohibition, including successful startup of facilities, residential and commercial connections to the project facilities, and cease discharge from OWDSs.

State of California
California Regional Water Quality Control Board, Los Angeles Region

Resolution No. R4-2009-xx

Amendment to the
Water Quality Control Plan for the Coastal Watersheds
of Ventura and Los Angeles Counties
to Prohibit On-site Wastewater Disposal Systems
in the Malibu Civic Center Area

WHEREAS, the California Regional Water Quality Control Board, Los Angeles Region (hereinafter Regional Board), finds that:

1. In the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* (hereafter *Basin Plan*), the Regional Board designated beneficial uses and established water quality objectives for the following water resources in the Civic Center area of the City of Malibu:

    Groundwater: Municipal and Domestic Supply (Potential), Industrial Process and Service Supply, and Agricultural Supply.

    Malibu Lagoon: Navigation; Water Contact Recreation; Non-contact Water Recreation; Estuarine Habitat; Marine Habitat; Wildlife Habitat; Rare, Threatened, or Endangered Species Habitat; Migration of Aquatic Organisms; Spawning, Reproduction, and/or Early Development; Wetland Habitat.

    Malibu Creek: Water Contact Recreation; Non-contact Water Recreation; Warm Freshwater Habitat; Cold Freshwater Habitat; Wildlife Habitat; Rare, Threatened, or Endangered Species Habitat; Migration of Aquatic Organisms; Spawning, Reproduction, and/or Early Development; Wetland Habitat.

    Malibu Beach and Malibu Lagoon Beach (Surfrider Beach), Amarillo Beach, and Carbon Beach: Navigation; Water Contact Recreation; Non-contact Water Recreation; Commercial and Sport Fishing; Marine Habitat; Wildlife Habitat; Spawning, Reproduction, and/or Early Development; and Shellfish Harvesting.

2. In a 2006 Clean Water Act Section 303(d) list, approved by the United States Environmental Protection Agency (US EPA) on June 28, 2007, impairments to beneficial uses were formally identified for the following water resources:

    Malibu Lagoon: impaired by Coliform Bacteria, Eutrophication.
    Malibu Creek: impaired by Coliform Bacteria, Nutrients (Algae).
    Malibu Beach: impaired by Indicator Bacteria.
    Malibu Lagoon Beach (Surfrider Beach): impaired by Coliform Bacteria.
    Carbon Beach: impaired by Indicator Bacteria.

3. To restore water quality and impaired beneficial uses, the US EPA and/or Regional Board have adopted the following Total Maximum Daily Loads (TMDLs):

   i. **Malibu Creek Watershed Nutrient TMDL:** The US EPA, on March 21, 2003, specified a numeric target of 1.0 mg/l for total nitrogen during summer months (April 15 to November 15) and a numeric target of 8.0 mg/L for total nitrogen during winter months (November 16 to April 14). Significant sources of the nutrient pollutants include discharges of wastewaters from commercial, public, and residential landuse activities. The TMDL specifies a load allocation for on-site wastewater disposal systems of 6 lbs/day during the summer months and 8 mg/L during winter months.

   ii. **Malibu Creek and Lagoon Bacteria TMDL**: The Regional Board specified numeric targets, effective January 24, 2006, based on single sample and geometric mean bacteria water quality objectives in the *Basin Plan* to protect the water contact recreation use. Sources of bacteria loading include storm water runoff, dry-weather runoff, on-site wastewater disposal systems, and animal wastes. The TMDL specifies load allocations for on-site wastewater disposal systems equal to the allowable number of exceedance days of the numeric targets. There are no allowable exceedance days of the geometric mean numeric targets. For the single sample numeric targets, based on daily sampling, in summer (April 1 to October 31), there are no allowable exceedance days, in winter dry weather (November 1 to March 31), there are three allowable exceedances days, and in wet weather (defined as days with >=0.1 and the three days following the rain event), there are 17 allowable exceedance days.

   iii. **Santa Monica Bay Beaches Wet and Dry Bacteria TMDL:** For beaches along the Santa Monica Bay impaired by bacteria in dry and wet weather, the Regional Board specified numeric targets, effective July 15, 2003, based on the single sample and geometric mean bacteria water quality objectives in the *Basin Plan* to protect the water contact recreation use. The dry weather TMDL identified the sources of bacteria loading as dry-weather urban runoff, natural source runoff and groundwater. The wet weather TMDL identified stormwater runoff as a major source. The TMDLs did not provide load allocations for on-site wastewater disposal systems, meaning that no exceedances of the numeric targets are permissible as a result of discharges from non-point sources, including on-site wastewater disposal systems. There are no allowable exceedance days of the geometric mean numeric targets. For the single sample numeric targets, based on daily sampling, in summer (April 1 to October 31), there are no allowable exceedance days, in winter dry weather (November 1 to March 31), there are three allowable exceedances days, and in wet weather (defined as days with >=0.1 and the three days following the rain event), there are 17 allowable exceedance days.

4. Pursuant to Water Code Section 13243, the Regional Board may, in its *Basin Plan*, specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted. During a public meeting on December 14, 1998, the Regional Board directed the Executive Officer to prepare a prohibition for consideration by the Regional Board. During a public meeting on November 13, 2008, the Regional Board discussed the need for a firm time schedule to address water quality problems in the Malibu Civic Center area and again directed staff to prepare a prohibition for Board consideration.

5. In accordance with the California Water Code, sections 13280 and 13281, Regional Board staff presented technical evidence, in a public hearing on October 1, 2009, demonstrating that discharges of wastewater in the Civic Center area fail to meet water quality objectives established in the *Basin Plan* and contribute to impairments of existing or potential beneficial uses of water resources. The evidence, as presented in a Technical Staff Report, includes the following conclusions:

   i. Dischargers subject to Orders from the Regional Board that specify waste discharge requirements (WDRs) for OWDSs have poor records of compliance.

   ii. Discharges of wastewaters released from OWDSs to groundwater contain elevated levels of pathogens and nitrogen that impair underlying groundwater as a potential source of drinking water.

   iii. Discharges of wastewaters released from OWDSs to groundwater that is in hydraulic connection with beaches along the mouths of unsewered watersheds transport pathogens that elevate risks of infectious disease for water contact recreation.

   iv. Discharges of wastewaters released from OWDSs to groundwater that is in hydraulic connection with Malibu Lagoon transport a nitrogen load significantly in excess of the wasteload allocation in the TMDL established to restore water quality to a level sufficient to protect aquatic life and prevent nuisance resulting from eutrophication.

   v. Wastewater flows in the Civic Center area have been increasing. On many sites, hydrogeologic conditions are unsuitable for high flows of wastewater, and many dischargers generate wastewater flows at rates that exceed their capacity to discharge on-site. These dischargers rely on pumping significant flows into tanker trucks that haul liquid sewage and sludge via public roadways to communities that have sewer and wastewater treatment facilities.

6. A peer review was conducted, pursuant to California Health and Safety Code section 57004.

7. No authorized public agency has offered satisfactory assurance that discharge systems are appropriately designed, located, sized, spaced, constructed, and maintained, such that they are adequate to protect the quality of water for beneficial uses in the Malibu Civic Center area, pursuant to the CWC section 13282.

8. Pursuant to the California Water Code, section 13283, the State Water Resources Control Board (State Board) shall include a preliminary review of possible alternatives necessary to achieve protection of water quality and present and future beneficial uses of water, and prevention of nuisance, pollution, and contamination, including, but not limited to, community collection and waste disposal systems which utilize subsurface disposal, and possible combinations of individual disposal systems, community collection and disposal systems which utilize subsurface disposal, and convention treatment systems. The Regional Board has conducted a preliminary review of possible alternatives, as documented in the staff report.

9. The basin planning process has been certified as functionally equivalent to the California Environmental Quality Act (CEQA), including preparation of an initial study, negative declaration, and environmental impact report (14 CCR, section 15251(g)). As this amendment is part of the basin planning process, staff has prepared an Environmental Staff Report, which is considered a substitute to an initial study, negative declaration, and/or environmental impact report. This Environmental Staff Report satisfies the substantive requirements of the California Code of Regulations, title 23, section 3777(a), and includes a project description, environmental checklist, reasonable alternatives, and mitigation measures.

THEREFORE, be it resolved that:

1. The Regional Board finds substantial evidence that discharges from septic systems in the Malibu Civic Center area fail to meet water quality objectives and impair both existing and potential beneficial uses of water, as documented in the Final Technical Staff Report, dated October 1, 2009. Pursuant to section 13240 of the California Water Code, the Regional Board hereby amends the *Basin Plan* to include a prohibition on discharges from individual/group septic/disposal systems in the Civic Center area. This amendment, as set forth in Attachment A, will:

   - Prohibit all new discharges.
   - Prohibit discharges from existing systems within five years from the date of adoption by the Regional Board of this *Basin Plan* amendment.
   - A specific discharge may be permitted for a “zero-discharge” project if a discharger can demonstrate, to the satisfaction of the Executive Officer, that reuse, evaporation, and/or transpiration will use 100% of the wastewater generated by activities on a site, will not contribute to a rise in the water table, and will contain and properly handle

any brines and/or off-specification wastewaters that cannot be reused/discharged in a manner that meets water quality objectives established in the *Basin Plan.*

2. The Regional Board adopts and certifies the Final Environmental Staff Report, including the environmental checklist, dated October 1, 2009.

3. The Regional Board directs the Executive Officer to submit these regulatory actions to the State Board and Office of Administrative Law for review and approval.

4. This prohibition is not intended to prevent repairs and maintenance to existing septic/disposal systems, provided that repairs and maintenance do not expand the capacity of the systems and increase flows of wastewaters.

5. On behalf of dischargers in the Civic Center area, the City is hereby directed to submit quarterly written reports to the Executive Officer, summarizing the strategy and progress toward meeting the five-year prohibition deadline. In the quarterly progress reports, the City shall document progress, to the satisfaction of the Executive Officer, toward the following interim and final deadlines:

   April 1, 2010: Completion of 25% of a master facilities plan for possible projects to comply with the prohibition, including initiation of a strong public participation program.

   October 1, 2010: Completion of 50% of a master facilities plan and initiation of environmental review, with strong, on-going public participation. Concurrently, initiation of preliminary engineering and a feasibility study for possible projects to comply with the prohibition.

   April 1, 2011: Substantial completion of a master facilities plan, preliminary engineering and a feasibility study, and engagement of the public in selection of a project to comply with the prohibition.

   October 1, 2011: Completion of a master facilities plan, preliminary engineering and a feasibility study, and selection of a project to comply with the prohibition.

   October 1, 2012: Completion of final design for selected project.

   October 1, 2013: Completion of 50% of construction of selected project.

   October 1, 2014: Completion of project to comply with prohibition, including successful startup of facilities, residential and commercial connections to the project facilities, and cease discharge from OWDSs.

The first progress report is due December 31, 2009, and subsequent quarterly progress reports are due on March 31st, June 30th, September 30th, and December 31st of the following years.

The City may, upon approval from the Executive Officer, transfer this responsibility to another public agency.

I, Tracy J. Egoscue, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Los Angeles Region, on October 1, 2009.

____

Tracy J. Egoscue
Executive Officer

Resolution No. R4-2009-xx

Amendment to the
Water Quality Control Plan for the Coastal Watersheds of
Ventura and Los Angeles Counties
to Prohibit On-site Wastewater Disposal Systems
in the Malibu Civic Center Area

Attachment A: Language to be inserted into the *Basin Plan*

The *Water Quality Control Plan for the Coastal Watersheds of Ventura and Los Angeles Counties* (*Basin Plan*) contains a section entitled "Septic Systems" in Chapter 4. This amendment to the *Basin Plan* revises the section entitled "Septic Systems," as indicated by italicized, underlined text for additions, and text strikeouts for deletions.

Septic Systems

~~The California Water Code, Chapter 4, Article 5, sets forth criteria for regulating individual disposal systems (i.e., residential septic tanks). Prior to the 1950s, the Regional Board placed certain types of septic tank systems under individual WDRs. In the 1950s, the regional Board delegates local health or public works departments jurisdiction to permit and regulate septic tank disposal systems, typically for single-family dwellings. However, the Regional Board could exercise jurisdiction over multiple-dwelling units, some non- domestic septic tank systems, and large developments in certain problem areas, as well as in any situation where systems are creating or have the potential to create a water quality problem.~~

Malibu Civic Center Area

On October 1, 2009, the Regional Board amended the Basin Plan *to prohibit on-site wastewater disposal systems (OWDSs) in the Malibu Civic Center area (figure 4-xx), pursuant to section 13280 of the California Water Code. Effective immediately:*

- *All new on-site wastewater disposal system discharges are prohibited.*
- *All wastewater discharges from existing on-site wastewater disposal systems are prohibited five yers from the date of adoption by the Region Board of this Basin Plan amendment.*
- *A specific wastewater discharge may be permitted if a discharger can demonstrate, to the satisfaction of the Executive Officer, that reuse, evaporation, and/or transpiration will use 100% of the wastewater generated by activities on a site, will not contribute to a rise in the water table, and will contain and properly handle any brines and/or off-specification wastewaters that cannot be reused/discharged in a manner that meets water quality objectives established in the Basin Plan.*

This action was supported by technical evidence that concluded:

i. *Dischargers subject to Orders from the Regional Board that specify waste discharge requirements (WDRs) for OWDSs have poor records of compliance.*

ii. *Discharges of wastewaters released from OWDSs to groundwater contain elevated levels of pathogens and nitrogen that impair underlying groundwater as a potential source of drinking water.*

iii. *Discharges of wastewaters released from OWDSs to groundwater that is in hydraulic connection with beaches along the mouths of unsewered watersheds transport pathogens that elevate risks of infectious disease for water contact recreation.*

iv. *Discharges of wastewaters released from OWDSs to groundwater that is in hydraulic connection with Malibu Lagoon transport a nitrogen load significantly in excess of the wasteload allocation in the TMDL established to restore water quality to a level sufficient to protect aquatic life and prevent nuisance resulting from eutrophication.*

v. *Wastewater flows in the Civic Center area have been increasing. On many sites, hydrogeologic conditions are unsuitable for high flows of wastewater, and many dischargers generate wastewater flows at rates that exceed their capacity to discharge on-site. These dischargers rely on pumping significant flows into tanker trucks that haul liquid sewage and sludge via public roadways to communities that have sewer and wastewater treatment facilities.*

The prohibition is not intended to prevent repairs and maintenance to existing septic/disposal systems, provided that repairs and maintenance do not expand the capacity of the systems and increase flows of wastewaters.

Oxnard Forebay Septic Prohibition

On August 9, 1999, the Regional Board amended the Basin Plan to include a prohibition on septic systems in the Oxford Forebay (figure 4-xx), pursuant to Section 13280 of the California Water Code. The prohibition applies to both future and existing septic systems in the Oxford Forebay. As of August 9, 1999, new septic systems in the Oxford Forebay were prohibited. By January 1, 2008, discharges from existing septic systems must cease. This action was taken in view of:

- The conclusion that discharges of wastewaters from residential and commercial facilities to groundwater underlying the Oxford Forebay do not meet water quality objectives specified in the Basin Plan, and are impairing the present and future beneficial uses of underlying resources of ground water.

- The need to ensure long-term protection of ground water underlying both the Oxford Forebay and the Oxford Plain. Alternatives to replace these supplies of local water, or to treat the water before beneficial use, would be costly and would violate the requirement to protect the water for beneficial uses.

The prohibition is not intended to prevent repairs to existing septic systems in the Oxford Forebay prior to [a date five year from Regional Board adoption of the amendment], provided that the purpose of such repairs is not to increase capacity.

Other Areas

In other areas, where ground water constitutes an important source of drinking water, the Regional Board has adopted general WDRs (Order 91-94) for certain private residential subsurface sewage disposal systems. A lot with size less then 1 acre in not eligible for these general WDRs; for those lots between one and less than five acres in size, the General WDRs require either a hyrdogeologic study or mitigation measures. WDRs are not required for lot sizes greater than five acres.

Attachment 2

Description of Scientific Issues to be addressed by Peer Review

The statute mandate for external scientific peer review (Health and Safety Code Section 57004) states that the reviewer's responsibility is to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices. We request that you make this determination for each of the following issues that constitute the scientific basis of the proposed regulatory action.

For Technical Memorandum #3: **Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment to Water Contact Recreation**, by Elizabeth Erickson, P.G.:

a. The interpretation of existing literature identifying factors that increase the risk of human enterococcus, human pathogens and human viruses at the beach.

b. The interpretation of the 1983 EPA marine health criteria for health risk as opposed to illness rate.

c. Unexplored or missing evidence that might link or refute a link between groundwater pathogens and beach pathogens in the Malibu Civic Center area, other than a multi-year and seasonal groundwater or epidemiology study.

d. The application of correlation coefficients and normal and rank interval statistical methods to the results of the investigation.

For Technical Memorandum #4: **Nitrogen Loads in Wastewaters flowing to Malibu Lagoon Are a Significant Source of Impairment to Aquatic Life**, by Toni Calloway, P.G, Orlando Gonzalez, and Dr. C.P Lai, P.E.

a. The approach used to compile an inventory of wastewater discharges from OWDSs in the Malibu Civic Center area, which staff estimates to total 255,000 gallons per day.

b. The methodology used to calculate loads of nitrogen from wastewaters discharged from OWDSs in the Malibu Civic Center area; specifically, staff's interpretation of published literature and assumptions used to calculate nitrogen loads released from OWDSs for those discharges where real data were not available.

c. Staff's characterization of groundwater flow regimes in the Malibu Civic Center area into five hydrogeologic sectors, and staff's application of the nitrogen loads (calculated from #2 above) into a 'spreadsheet' model that estimates attenuation of nitrogen loads released from OWDSs and transported to Malibu Lagoon (i.e. to the point of groundwater recharge into the lagoon) for each hydrogeologic sector.

d. Staff's use of the updated nitrogen loads released from OWDSs (calculated from #2 above) to adjust (update) estimates of nitrogen transported to Malibu Lagoon (i.e. to the point of groundwater recharge into the lagoon), using a relationship already established by a groundwater flow and transport model (which is already accepted by stakeholders in the community).

Finally, reviewers are not limited to addressing only the specific issues presented above, and we request the scope of the peer review response include the following overarching questions:

(a) In reading Tech Memos #3 and #4, are there any additional scientific issues, not described above, that are part of the scientific basis of the proposed rule? If so, please comment with respect to the statute language given above.

(b) Taking each of Tech Memo #3 and #4 as a whole, is the conclusion of each tech memo based on sound scientific knowledge, methods, and practices?

Reviewers should also note that some proposed actions may rely significantly on professional judgment where available scientific data are not as extensive as desired to support the statue requirement for absolute scientific rigor. In these situations, the proposed course of action is favored over no action.

The preceding guidance will ensure that reviewers have the opportunity to comment on all aspects of the scientific basis of the proposed Board action. At the same time, reviewers also should recognize that the Board has a legal obligation to consider and respond to all feedback on the scientific portions of the proposed rule. Because of this obligation, reviewers are encouraged to focus feedback on the scientific issues that are relevant to the central regulatory elements being proposed.

Attachment 3 – List of Participants

Technical Staff at the Los Angeles Regional Water Quality Control Board:

Wendy Phillips, P.G., C.E.G, C.H.G., Chief, Groundwater Permitting and Landfills Section

Dr. Rebecca Chou, P.E., Chief, Groundwater Permitting Unit

Elizabeth Erickson, P.G., Engineering Geologist, Groundwater Permitting Unit

Toni Callaway, P.G., Engineering Geologist, Groundwater Permitting Unit

Orlando Gonzalez, Water Resources Control Engineer, Groundwater Permitting Unit

Dr. C.P. Lai, P.E., TMDL Unit

Jenny Newman, Chief, TMDL Unit

This page intentionally left blank.

<u>Attachments 4, 4.a, and 4.b</u>

3. Technical Staff Report (Overview – draft dated July 31, 2009), in support of an Amendment to the *Water Quality Control Plan for Coastal Watersheds of Los Angeles and Ventura Counties* to Prohibit On-Site Wastewater Disposal Systems in the Malibu Civic Center Area, plus Tech Memos #3 and #4:[1]

    a. Technical Memorandum #3: **Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment to Water Contact Recreation**, by Elizabeth Erickson, P.G. (draft dated July 31, 2009)

    b. Technical Memorandum #4: **Nitrogen Loads in Wastewaters flowing to Malibu Lagoon Are a Significant Source of Impairment to Aquatic Life**, by Toni Calloway, P.G, Orlando Gonzalez, and Dr. C.P Lai, P.E. (draft dated August 4, 2009)

[1] Other tech memos and materials related to this proposed regulatory action, may be accessed and downloaded at http://www.waterboards.ca.gov/losangeles/press_room/announcements/Public Hearing-Malibu/index.shtml.

This page intentionally left blank.

State of California
California Regional Water Quality Control Board, Los Angeles Region

Draft Technical Staff Report

Evidence in support of an Amendment to the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*

to Prohibit On-site Wastewater Disposal Systems in the Malibu Civic Center Area

July 31, 2009

D R A F T J U L Y 3 1 2 0 0 9

Table of Content

State of California
California Regional Water Quality Control Board, Los Angeles Region

D R A F T J U L Y 3 1 2 0 0 9

Draft Technical Staff Report

Evidence in support of an Amendment to the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* to incorporate a Prohibition on On-site Wastewater Disposal Systems in the Malibu Civic Center Area

Technical Staff Report Overview

by
Wendy Phillips,* P.G., C.H.G., C.E.G.
Chief, Groundwater Permitting and Landfill Section

**In addition to her current colleagues in the Groundwater Permitting Unit, the author expresses appreciation for TMDL contributions from Jenny Newman, CP Lai and Eric Wu, post-production contributions from Rosie Villar, Enrique Casas, Jeff Ogata, Rodney Nelson, and Joe Luera, and contributions from past colleagues Rick Viergutz, Hugh Marley, Morton Price, and Dennis Dickerson.*

Technical Staff Report Overview

by
Wendy Phillips, P.G., C.H.G., C.E.G.
Chief, Groundwater Permitting and Landfill Section

Introduction

The purpose of this Technical Staff Report is to present evidence in support of an amendment to the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan),* to prohibit subsurface disposal systems in the Malibu Civic Center area. The Malibu Civic Center area, shown in Figure 1, includes Malibu Valley, Winter Canyon, and the adjacent coastal strips of land and beaches. Types of subsurface disposal systems that would be prohibited by the amendment to the *Basin Plan* range from passive systems with conventional septic tanks to active systems that more aggressively remove pollutant loads from sewage before subsurface disposal. The prohibition would apply to systems that serve individual properties (residential, commercial, industrial, and public properties) as well as groups of those properties. Collectively throughout this report, these disposal systems are referred to as on-site wastewater disposal systems, or OWDSs.

Environmental Setting

Background

The Malibu Civic Center area supports a population of about 1,000 residents and is the core of the City's business, cultural, and commercial activities. The area, which includes the renowned Surfrider Beach, attracts a high volume of visitors.

Without community sewers and wastewater treatment infrastructure, residents, businesses, and public facilities in the City of Malibu use thousands of on-site disposal systems to discharge their sewage to the subsurface and underlying groundwater. In several areas of the City, unfavorable hydrogeologic conditions coupled with high flows of wastewaters have raised concerns about reliance on this wastewater disposal strategy. In one of those areas of concern, the Malibu Civic Center area, intensive land use activities by almost 400 dischargers result in the release of wastewaters to the subsurface at a rate that Regional Board staff estimates to be as high as 255,000 gallons per day (gpd).

Water Resources

Surface waters in the Malibu Civic Center area include Malibu Creek, Malibu Lagoon – a fresh/saltwater habitat for rare, threatened, and endangered species, and ocean beaches, which are heavily used by the resident population as well as visitors. Groundwater in the area is a historic and potential source of drinking water. In the *Basin Plan*, the Regional Board has formally designated these plus other beneficial uses for the water resources in the area as follows:

Malibu Lagoon: Navigation; Water Contact Recreation; Non-contact Water Recreation; Estuarine Habitat; Marine Habitat; Wildlife Habitat; Rare, Threatened, or Endangered Species Habitat; Migration of Aquatic Organisms; Spawning, Reproduction, and/or Early Development; Wetland Habitat.

Malibu Creek: Water Contact Recreation; Non-contact Water Recreation; Warm Freshwater Habitat; Cold Freshwater Habitat; Wildlife Habitat; Rare, Threatened, or Endangered Species Habitat; Migration of Aquatic Organisms; Spawning, Reproduction, and/or Early Development; Wetland Habitat.

Malibu Beach and Malibu Lagoon Beach (Surfrider Beach), Amarillo Beach, and Carbon Beach: Navigation; Water Contact Recreation; Non-contact Water Recreation; Commercial and Sport Fishing; Marine Habitat; Wildlife Habitat; Spawning, Reproduction, and/or Early Development; and Shellfish Harvesting.

Groundwater: Municipal and Domestic Supply (Potential), Industrial Process and Service Supply, and Agricultural Supply.

Also in the *Basin Plan,* the Regional Board has established water quality objectives to protect the beneficial uses identified above.

Impairments to Beneficial Uses of Water Resources

In a 2006 Clean Water Act Section 303(d) list, approved by the United States Environmental Protection Agency (US EPA) on June 28, 2007, impairments to beneficial uses are formally identified for the following water resources:

Malibu Lagoon: impaired by Coliform Bacteria, Eutrophication.
Malibu Creek: impaired by Coliform Bacteria, Nutrients (Algae).
Malibu Beach: impaired by Indicator Bacteria.
Malibu Lagoon Beach (Surfrider Beach): impaired by Coliform Bacteria.
Carbon Beach: impaired by Indicator Bacteria.

To restore water quality and impaired beneficial uses, the US EPA and/or Regional Board have adopted the following Total Maximum Daily Loads (TMDLs):

a. **Malibu Creek Watershed Nutrient TMDL:** The US EPA, on March 21, 2003, specified a numeric target of 1.0 mg/l for total nitrogen during summer months (April 15 to November 15) and a numeric target of 8.0 mg/L for total nitrogen during winter months (November 16 to April 14). Significant sources of the nutrient pollutants include discharges of wastewaters from commercial, public, and residential landuse activities. The TMDL specifies a load allocation for on-site wastewater disposal systems of 6 lbs/day during the summer months and 8 mg/L during winter months.

b. **Malibu Creek and Lagoon Bacteria TMDL:** The Regional Board specified numeric targets, effective January 24, 2006, based on single sample and geometric mean bacteria water quality objectives in the *Basin Plan* to protect the water contact recreation use. Sources of bacteria loading include storm water runoff, dry-weather runoff, on-site wastewater disposal systems, and animal wastes. The TMDL specifies load allocations for on-site wastewater disposal systems equal to the allowable number of exceedance days of the numeric targets. There are no allowable exceedance days of the geometric mean numeric targets. For the single sample numeric targets, based on daily sampling, in summer (April 1 to October 31), there are no allowable exceedance days, in winter dry weather (November 1 to March 31), there are three allowable exceedances days, and in wet weather (defined as days with >=0.1 and the three days following the rain event), there are 17 allowable exceedance days.

c. **Santa Monica Bay Beaches Wet and Dry Bacteria TMDL:** For beaches along the Santa Monica Bay impaired by bacteria in dry and wet weather, the Regional Board specified numeric targets, effective July 15, 2003, based on the single sample and geometric mean bacteria water quality objectives in the *Basin Plan* to protect the water contact recreation use. The dry weather TMDL identified the sources of bacteria loading as dry-weather urban runoff, natural source runoff and groundwater. The wet weather TMDL identified stormwater runoff as a major source. The TMDLs did not provide load allocations for on-site wastewater disposal systems, meaning that no exceedances of the numeric targets are permissible as a result of discharges from non-point sources, including on-site wastewater disposal systems. There are no allowable exceedance days of the geometric mean numeric targets. For the single sample numeric targets, based on daily sampling, in summer (April 1 to October 31), there are no allowable exceedance days, in winter dry weather (November 1 to March 31), there are three allowable exceedances days, and in wet weather (defined as days with >=0.1 and the three days following the rain event), there are 17 allowable exceedance days.

Summary of Evidence

Staff investigations focused in five areas and are presented in five technical memoranda that comprise this staff report, and that meet the requirements of the California Water Code, sections 13280 and 13281 for determination that discharges of OWDSs in the Malibu Civic Center area result in violation of water quality objectives, will impair present or future beneficial uses of water, will cause pollution, nuisance, or contamination, or will unreasonably degrade the quality of any water of the state.

Technical Memorandum #1: Permitted Dischargers Have Poor Records of Compliance with Regional Board Orders.

For the privilege of discharging wastewater to a water of the state (including both surface water and groundwater), dischargers must comply with waste discharge requirements (WDRs) that are specified in Orders issued by the Regional Board. The WDRs generally incorporate monitoring and reporting programs that rely on self-monitoring by dischargers. The reports of self-monitoring are used by the Regional Board to determine compliance and to ensure that the quality of the water into which wastes are discharged is not degraded and that beneficial uses, such as drinking water and swimming (body contact recreation) are protected.

In the Malibu Civic Center area, the Regional Board regulates 21 discharges, all of which are from commercial, industrial, or public facilities. In a review of the compliance records for 20[1] of the 21 discharges, each dischargers had a record of violations. Among the most serious violations are repeated failures to achieve effluent limits specified in WDRs; in particular, limits for pathogens and nutrients (species of nitrogen and phosphorus) that are identified as pollutants in nearby waters that the Regional Board and EPA have designated as impaired under Clean Water Act section 303(d). Also, several dischargers 'failed to submit' monitoring reports, and compliance with technical requirements in their WDRs could not be determined.

Among the minor violations included in Table 1-1 are tardy submittal of reports of self-monitoring required by the WDRs and improper certifications of those monitoring reports – e.g. a perjury statement executed by a party not authorized to certify the accuracy of the results on behalf of the discharger, and/or modifications to the language of the perjury statement that is specified in a WDR.

Staff concludes that dischargers have poor records of compliance with Orders issued by Regional Board, and that discharges are, in general, not meeting requirements prescribed to protect water quality and beneficial uses.

Technical Memorandum #2: Pathogens and Nitrogen in Wastewaters Impair Underlying Groundwater as a Potential Source of Drinking Water.

Although groundwater in the Malibu Valley Groundwater Basin is not an existing source of drinking water to the community, groundwater was the community's source of drinking water until the 1960s. Groundwater production in the area gradually ceased as a newly formed special district – Los Angeles County Waterworks District No. 29, Malibu – started delivering imported water to the Malibu area and Topanga Canyon in the early 1960s. As a future resource – and also in the event of a disruption of deliveries of imported water, groundwater is an important local resource that the community may need to use in the future. The Regional Board recognized this beneficial use, in designating groundwater as a potential source of drinking water in the *Basin Plan*.

To evaluate impacts from OWDSs on groundwater as a potential source of drinking water, staff identified 47 groundwater wells, all of which were designed and constructed for monitoring the quality of groundwater, and compiled data pathogens and nitrogen. To examine the extent of impairment of this groundwater for drinking water, staff compiled all available analytical results of sampling for pathogen indicators and nitrogen species during the period July 2002 through May 2009 and compared these results with drinking water standards for these pollutants. As summarized in graphs and tables for each well:

[1] One discharger, Malibu Lumber, did not commence discharge until April 2009, subsequent to the staff's evaluation of compliance records. Since commencement of the discharge, this discharger has been in violation of its WDR.

- ***Pathogens in Groundwater do not meet the Drinking Water Standard:*** Forty-four wells, or 94% of the 47 wells, had fecal coliform during at least one sampling period. Of the 671 fecal coliform samples collected from the 47 wells during the review period, 360 samples (54%) tested positive and exceeded the maximum contaminant level (MCL) of less than 1.1 MPN/100ml (Most Probable Number per 100 milliliters).

- ***Nitrogen in Groundwater does not meet the Drinking Water Standard:*** Fourteen wells, or 30% of the 47 wells, had nitrate plus nitrite at levels above the MCL of 10 mg/L (as nitrogen). Of the 671 samples collected from the 47 wells during the review period, 100 (15%) were above the MCL. Although there is no drinking water standard for ammonia, staff also reviewed analytical data for ammonia in view of the likelihood that the ammonia species of nitrogen will nitrify. These results indicate that, when concentrations of ammonia (converted to nitrogen) are added to concentrations of nitrate and nitrite, 163 samples or 24% were above the MCL. Twenty-four wells, or 51% of the 47 wells, had levels above the MCL of 10 mg/L.

As indicated by coliform results, pathogens are present in groundwater at levels that elevate the risk of infectious disease should this groundwater be used for potable purposes. As indicated by the nitrogen results, species of nitrogen are present in groundwater at levels that can cause health problems in humans should this groundwater be used for potable purposes. Infants and fetuses are particularly sensitive and can develop methemoglobinemia (blue-baby syndrome) from ingestion of water with nitrate at levels that deplete oxygen in the blood stream.

Technical Memorandum #3: Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment to Water Contact Recreation.

Malibu Creek, Lagoon, and nearby beaches are popular not only within the local community but as a destination for visitors as well. In the *Basin Plan,* the Regional Board has designated these waters for both water contact recreation (e.g. swimming) and non-contact water recreation (e.g. sunbathing, aesthetic enjoyment), and set standards at levels that will protect human health.

As determined by the Regional Board and US Environmental Protection Agency, surface waters in the Malibu Creek Civic Center area are impaired for water contact recreation, consistently failing to meet standards set to protect swimmers and surfers from infectious disease resulting from direct exposure to or incidental ingestion of polluted waters during recreation. Repeated failures to meet standards for standards have resulted in a 'beach bummer' reputation for the renowned Surfrider Beach.

To examine the hydraulic connection of discharges from OWDSs through groundwater to nearby surface waters, staff evaluated more than 8,000 samples of wastewater effluent, underlying or nearby groundwater, and surface waters. Staff determined that pathogens from wastewaters migrate to surface waters and that, consistent with data supporting the designations of impairments, the levels of pathogens do not meet standards protective of human health. Staff also determined that risks of infectious disease from water contact recreation were elevated at beaches in the Malibu Civic Center area versus comparable beaches with sewers.

Staff also reviewed numerous previous studies, and found conclusions from these other studies to be consistent with staff's determination of impairment to beneficial use of water contact recreation.

5

Technical Memorandum #4: Nitrogen Loads in Wastewaters flowing to Malibu Lagoon Are a Significant Source of Impairment to Aquatic Life.

Malibu Lagoon supports a valuable wetland ecosystem and nearby plant communities such as the the coastal salt marsh and the coastal strand, and also serves as refuge for migrating birds (with over 200 observed species). These beneficial uses are impaired by excessive nutrients levels in the lagoon, depleting dissolved oxygen in the water and stimulating aquatic growth (algae). As established in the nutrient TMDL[2] adopted by the US EPA on March 21, 2003 for Malibu Lagoon, nitrogen from OWDSs in hydraulic connection with the lagoon are subject to a load allocation of six pounds per day.

To quantify current nitrogen loads from OWDSs in the Malibu Civic Center area to the lagoon, staff compiled an inventory of 38 commercial dischargers and 349 residential dischargers. Using real data where available and reasonable assumptions (based on published literature and best professional judgment) for data gaps, staff calculated that the dischargers release about 255,000 gpd through OWDSs and estimated nitrogen loading factors. Applying these nitrogen loading factors to update an existing numerical model designed and calibrated by Questa 2005 for an earlier investigation, staff estimates that nitrogen loads released from OWDSs and transmitted via groundwaters to Malibu Lagoon total 29 pounds per day (lb/day). As a check, staff used the same flows and loading factors to a 'spreadsheet' model which characterized wastewater transport by hydrogeologic sector. Based on the 'spreadsheet' model, staff estimates that wastewaters transport 36 lb/day into Malibu Lagoon.

Staff's estimates of 29 lb/day to 36 lb/day from the numeric and 'spreadsheet' models are greater than two of the estimates (17 lb/day to 20 lb/day) prepared by the third parties in previous studies, and slightly overlap the estimate by the other third party (32 lb/day). Among the factors accounting for the range in estimates between staff's estimates and third-party estimates are:

- Commercial Flows: The third-party models used significantly lower assumptions for commercial wastewater flows.
- Nitrogen Concentrations – Residential: Two of the three third-party models assumed that residential wastewaters have nitrogen concentrations that are about one-half of what staff determined is a reasonable assumption.
- Nitrogen Concentration – Commercial: Staff determined that the average nitrogen concentration of commercial wastewater discharges has decreased since 2004, as OWTSs

[2] In the Malibu Creek Watershed Nutrient TMDL (March 21, 2003), the US EPA specifies a numeric target of 1.0 mg/l for total nitrogen during summer months (April 15 to November 15) and a numeric target of 8.0 mg/L for total nitrogen during winter months (November 16 to April 14). Significant sources of the nutrient pollutants include discharges of wastewaters from commercial, public, and residential land use activities. The TMDL specifies a load allocation for on-site wastewater treatment systems of 6 lbs/day during the summer months and 8 mg/L during winter months.

with greater treatment capabilities has been brought on-line. However, this declining trend in this subset of OWTSs is not great enough to meet the TMDL goal.

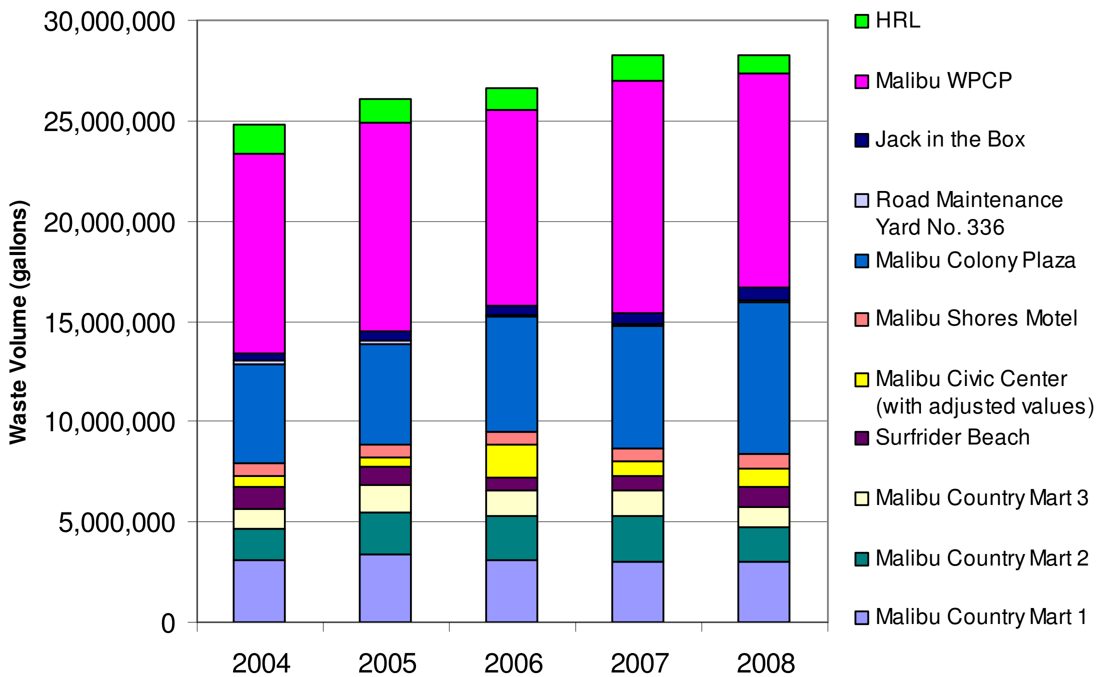
Regardless of differing assumptions and models used in the estimates, all estimates – including those prepared by staff as well as past estimates prepared by third parties – indicate that nitrogen loads from OWDSs are significantly above the load allocation of 6 lb/day for OWDSs established in a TMDL. Accordingly, staff concludes that OWDSs in the Malibu Civic Center area cumulatively release nitrogen at rates that contribute to eutrophication and impair aquatic life in Malibu Lagoon. This conclusion is supported by staff's estimates ranging from 29 lb/day to 36 lb/day as wells as third-party estimates from 17 lb/day to 32 lb/day, all of which fail to meet targets established to restore water quality and protect beneficial uses in Malibu Lagoon.

Technical Memorandum No. 5: Dischargers with Unsuitable Hydrogeologic Conditions for High Flows of Wastewaters Resort to Hauling Liquid Sewage and Sludge to Communities that have Sewer and Wastewater Treatment Facilities.

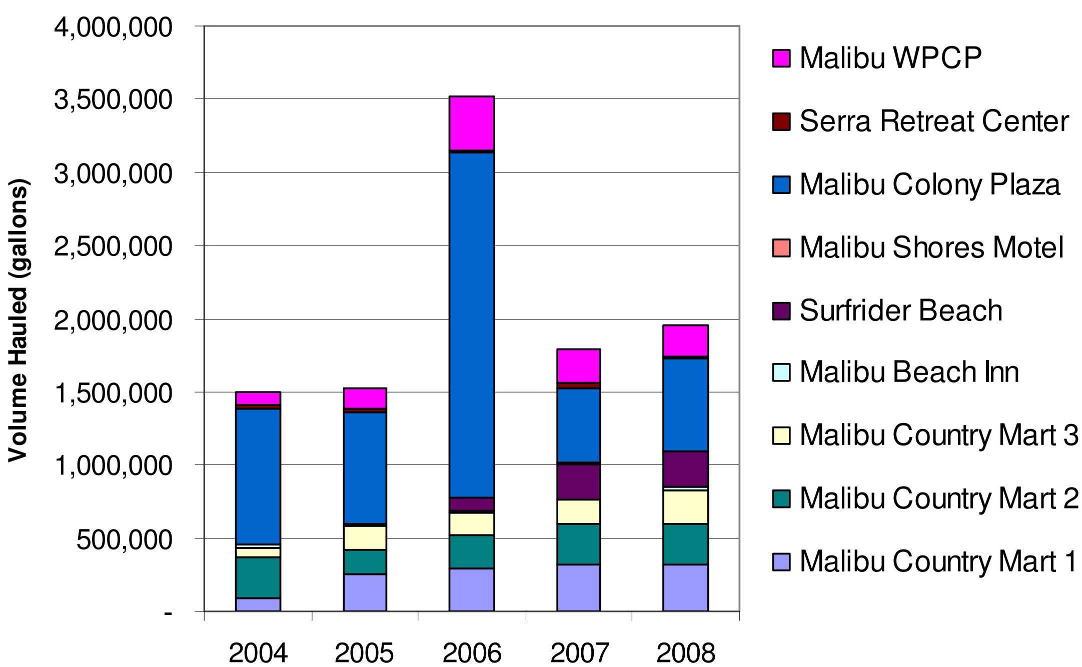
Intensive land use activities on many properties in the Malibu Civic Center area generate wastewater flows at rates that exceed the capacity of OWDSs to transmit the wastewaters into the subsurface. While some dischargers are limited by treatment equipment that has inadequate capacity and/or treatment capabilities, many dischargers do not have adequate disposal capacity on their properties to transmit the wastewaters into the subsurface. Their disposal rates can be constrained not only by lack of space, or area, for on-site disposal fields, but by hydrogeologic constraints as well, such as a high water table or tight soils. Consequently, in order to avoid failure of the OWDSs, a significant number of large dischargers resort to hauling liquid sewage and sludge to communities that have infrastructure to accept their liquid wastes.

To quantify reliance on the practice of hauling, staff reviewed reports of self-monitoring, which include summaries of off-site hauling, submitted by ten large commercial dischargers. In 2008, these ten dischargers, whose activities generated a total of approximately 28 million gallons of wastewater (77,000 gpd), hauled almost 2 million gallons (5,500 gpd), or about 7%, of their raw sewage to off-site disposal facilities. Furthermore, staff quantified trends from 2004 through 2008, which indicate that these ten dischargers have cumulatively increased their rate of wastewater generation by 15% and their rate of hauling by 29%. (Staff was not unable use existing data from dischargers to analyze seasonal hauling trends – e.g. hauling trends during the wet season, and also during warm summer holidays when populations have high peaks.)

Combined Annual Waste Flows for Select Dischargers



Combined Annual Septic Waste Hauling for Select Dischargers



DRAFT JULY 31 2009

Staff also considered the carbon footprint of hauling practices, which generally use large diesel-powered tanker trucks that have to travel between 60 and 180 miles round trip to transport sewage. Staff estimates that hauling by these vehicles releases over 250 tons of carbon dioxide each year. Eliminating the need for sewage waste hauling would contribute toward the goals of California's Global Warming Solution Act by decreasing greenhouse gas emissions. Also, elimination of excessive hauling can help reduce public nuisances, such as traffic, noise, and odor resulting from these practices.

Conclusions

Discharges of wastewaters to the subsurface through OWDSs have degraded water resources and impaired existing and potential beneficial uses of these waters, as determined by the following conclusions from the technical memoranda.

i. Dischargers subject to Orders from the Regional Board that specify waste discharge requirements (WDRs) and Time Schedule Orders (TSOs) have poor records of compliance.

ii. Discharges of wastewaters contain elevated levels of pathogens and nitrogen that impair the underlying groundwater as a potential source of drinking water.

iii. Discharges of wastewaters to groundwater that is in hydraulic connection with beaches along the mouths of unsewered watersheds contain levels of pathogens that elevate risks of infectious disease for water contact recreation.

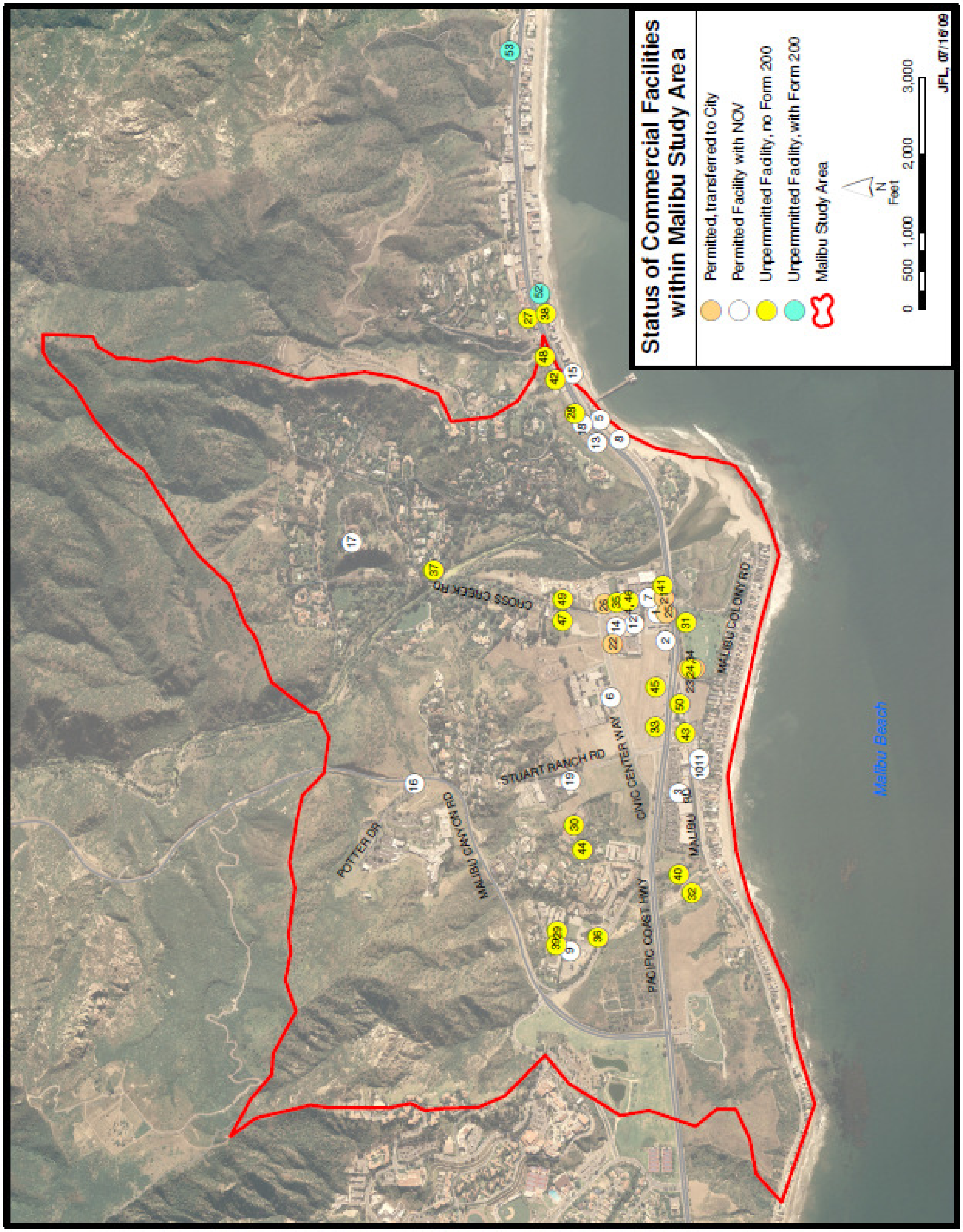
iv. Discharges of wastewaters that flow through groundwater and recharge Malibu Lagoon transport a nitrogen load significantly in excess of the allocation in the TMDL established to restore water quality to a level sufficient to protect aquatic life and prevent nuisance resulting from eutrophication.

v. Generation of wastewater flows in the Civic Center area has been increasing. On many sites, hydrogeologic conditions are unsuitable for high flows of wastewater, and many dischargers generate wastewater flows at rates that exceed their capacity to discharge on-site. These dischargers rely on pumping significant flows into tanker trucks that haul liquid sewage and sludge via public roadways to communities that have sewer and wastewater treatment facilities.

Recommendation

Staff recommends that the Regional Board adopt Resolution R4-2009-xx to immediately prohibit all future discharges of wastewaters and to prohibit existing discharges of wastewater within five years of the Regional Board’s adoption, i.e. by October 1, 2014.

Figure 1: Malibu Civic Center Area



This page intentionally left blank.

State of California
California Regional Water Quality Control Board, Los Angeles Region

D R A F T   J U L Y   3 1   2 0 0 9

Draft Technical Staff Report

Evidence in support of an Amendment to the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*

to Prohibit on On-site Wastewater Disposal Systems in the Malibu Civic Center Area

Technical Memorandum #3: *Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment for Water Contact Recreation*

By
Elizabeth Erickson,* Registered Geologist
Groundwater Permitting Unit

** The author would like to thank Regional Board staff, Joe Luera and interns Albert Chu, Shentong Lu, Shannon Liou, Justin Tang, Tessa Nielsen, Holly MacGillivray, Thomas Palmieri, Ryan Thatcher and Yifei Tong for their assistance in preparing map, tables and graphs.*

Technical Memorandum #3: ***Pathogens in Wastewaters that are in Hydraulic Connection with Beaches are a Significant Source of Impairment for Water Contact Recreation***

By
Elizabeth Erickson, Registered Geologist
Groundwater Permitting Unit

1. Purpose

The purpose of the study is (a) to measure the discharge of enterococcus, a fecal-indicator-bacteria for human pathogens, from septic systems (On-site Wastewater Disposal Systems or OWDS) in the Malibu Civic Center onto adjacent surface waters and beaches, and (b) to determine human health impacts of septic system wastewater disposal on beach users.

2. Study Design and Data

The study design is (a) to examine the distribution of bacteria in groundwater beneath the Malibu Civic Center area, (b) to use beach studies to determine likely fate and transport paths and (c) to use epidemiology studies to estimate health impacts.

Fecal-indicator-bacteria are identified in septic discharge, in leachfields/seepage pits, in groundwater, in streams and beaches and, through rainfall records and frequency distributions, related to groundwater discharge. On-site Wastewater Disposal System performance data from reporting permitted commercial facilities, groundwater monitoring data and beach monitoring data at the Malibu Civic Center are studied for the presence of enterococcus bacteria, which can originate in the human gut, have been used as indicators of human pathogens, and are the basis of a marine recreational criteria for the protection of human health.

The Los Angeles Regional Water Quality Control Board (Regional Board) was tasked with permitting about 40 commercial facilities in the study area after the year 2000 when the State Water Resource Control Board (SWRCB) eliminated waivers for septic systems. Twenty one permitted facilities were transferred to the City of Malibu for oversight under Memorandum of Understanding signed in 2004. Twenty permitted commercial facilities are under Regional Board's oversight. Notices of Violation (NOV) were issued in the spring of 2009 to 20 facilities for non-compliance with WDR and Time Schedule Orders including failure to submit monitoring reports. Of the permitted septic systems which provided monitoring information, four provided end-of-pipe measures and ten submitted groundwater monitoring results. End-of-pipe discharge reports from permitted systems describe effluent as it enters the leachfield/seepage pit. Enterococcus densities were also examined in groundwater monitoring wells surrounding the leachfields which receive septic system effluent.

The City of Malibu measures groundwater quality periodically throughout the Malibu Valley basin which receives the effluent from the septic systems in the Civic Center. The ground water monitoring of 20 wells in the Malibu Civic Center area was completed by the City of Malibu in 2004 and summarized by Stone Environmental, Inc. (Stone) in 2004, but water level and water quality monitoring information collected since that date has not been submitted to the Regional Board and is not included in this analysis.

State and local agencies and nonprofit organizations measure enterococcus in the surface waters and on the beaches adjacent to the Malibu Civic Center area and these records were examined. As an example, beach data was collected as part of the Coordinated Shoreline Monitoring Plan for Santa Monica Bay beaches and the result of a multi-jurisdictional collaborative effort, involving representatives from (a) municipalities and public agencies responsible for the implementation of the Santa Monica Bay Beaches Bacteria Total Maximum Daily Loads (TMDLs), (b) the Regional Board, and (c) the environmental advocacy groups. The "Santa Monica Bay Beaches Bacteria Total Maximum Daily Load Coordinated Site Monitoring Plan, April 7, 2004" (CSMP) went into effect on April 28, 2004 and can be found at http://ladpw.org/wmd/npdes/beachplan.cfm . All sampling procedures are standardized, including morning sampling in ankle-deep water at fixed points with testing in State certified laboratories.

The CSMP monitoring sites were selected to sample the wave wash of 55 miles of shoreline encircling Santa Monica Bay. The sites include major drains that have measurable flow to the beach at the wave wash during the wet weather and beaches that are used for wading and swimming. Each subwatershed was represented by at least one sampling site. Where a storm drain of freshwater outlet is absent, the midpoint of the beach is used. Based on observations of the Santa Monica Bay Restoration Commission staff and Regional Board staff, only the monitoring sites at Santa Monica Canyon and Ballona Creek have flow to the beach wave wash during dry weather throughout August, September, October and November of each sample year.

Among the beach monitoring information collected, the study focused on records for June through August in 2005, May through October in 2006, April through October in 2007, and May through October in 2008, on a total of 58 beaches, 36 of which receive freshwater drainage (with MS-4 stormwater permits) and 22 of which do not. The beaches stretch from El Pescador Beach in the northwest to Redondo Beach in the southeast. Winter data was not evaluated as septic discharge through groundwater to the beach is anticipated to be smaller in contrast to stormwater bacteria discharge to the beaches after rain events.

The sample sites were sorted according to characteristics, such as watershed size, land-use, fecal-indicator-bacteria concentrations, septic system presence, wave strength and beach visitor population. A full array of site characteristics were found to be represented: sewage or septic system waste treatments, adjacent groundwater levels of enterococcus levels above 1 MPN/100mL, watershed sizes ranging from 813 acres to 81,980 acres, urban acres ranging from 128 acres to 68,700 acres, and wave action identified from surf web-sites ranging from none to persistent. Some beaches had adjacent lagoons, tidally influenced pools, stormwater containments and low flow diversions.

Two epidemiology studies, one by the U.S. Environmental Protection Agency (EPA) used in the development of the existing marine recreational swimming criteria based on enterococcus densities, and a recent study from Wisconsin (Borchardt, 2003) correlating health impacts on children to septic system density, were used to estimate the human health effects of a septic system disposal for the Malibu Civic Center

Attachment 3-1 contains a discussion of the statistical analysis completed as part of this study. Attachment 3-2 contains an expanded reference list.

Groundwater Discharge

This study examines correlations between bacteria distributions in groundwater basin, surface waters and on many beaches with different characteristics. A different study design would be necessary to confirm causation. For the purposes of this study, groundwater discharge is defined as any flow which passes through the beach face or subsurface to enter the wave zone. It may be comprised of varying volumes of (a) stormwater or urban runoff which has entered the groundwater upgradient from the beach and discharges at the beach, (b) septic effluent which enters the groundwater as a discrete plume or with mixing and discharges at the beach, (c) groundwater which has resided for longer than a season in the aquifer and discharges at the beach. In every beach studied, except Ballona Creek and Santa Monica Canyon beaches, freshwater entering the wave zone must pass through the sand of the beach face during some of the summer months.

When septic beaches are compared with sewered beaches during dry weather, septic beaches may receive groundwater discharge of septic effluent, urban flows, and groundwater, while sewered beaches are limited to a mix of urban and groundwater flows.

Peer Review

A peer review of a portion of this work was conducted between June 8, 2009, and the public release of this document. An early technical review resulted in recommendations from the reviewers (a) to enhance the confidence of the conclusions using statistics, (b) to recommend additional studies to confirm and extend the results shown here, and (c) to emphasize the complexity of the subsurface hydraulic and microbiological environment between septic discharge and the ocean which have limited a simple characterization of a relationship between human illness from marine recreational swimming and coastal septic use. In response to these comments, additional statistical results were completed and the qualitative conclusions were made on human health risks. The external technical reviewers were Dr. Mark Gold (Heal the Bay), Mr. Steve Weisberg and Dr. John Griffith (Southern California Coastal Water Research Project or SCCWRP), Dr. Alexandria Boehm (Stanford University) and Dr. John Izbicki (US Geological Survey), all of whom have completed research on pathogens on beaches.

Dr. C.Y. Jeng (Department of Toxic Substances Control) provided helpful discussions on statistics.

Integration with Ongoing Studies

An epidemiology study of Surfrider Beach by SCCWRP is planned for the summer of 2009. Groundwater assessment is planned for a seven-day period in July 2009 by Dr. John Izbicki. While providing critical and important information, these two studies are limited in their ability to deny a causal relationship between septic systems and bacteria because (a) groundwater and epidemiology are not examined over an extended period of time and (b) groundwater identification of bacteria transport is repeatedly confounded by time, tide and effluent pathway dependent variations (Boehm et. al., 2004). Descriptions of the ongoing studies are available from the Regional Board.

3. Results

Bacteria in Groundwater

Enterococcus bacteria are found being discharged from OWDS, in the adjacent leachfields/seepage pits, throughout the groundwater basin, and in the subsurface adjacent to Malibu Creek, Lagoon and the Civic Center Beaches.

End-of-pipe bacteria measurements were reported for four permitted sites in the Malibu Civic Center. Half of the measures show enterococcus bacteria concentrations larger than or equal to total or fecal coliform measures[1]. The data show the typical wide variation in measures of water samples examined for this study.

All four reporting sites had disinfection so the end-of-pipe measures show events which are present during the failure of chlorine, ultraviolet or ozone treatment. Technical memorandum #1 quantifies the frequency of these failures as does the permit violations notices discussed above.

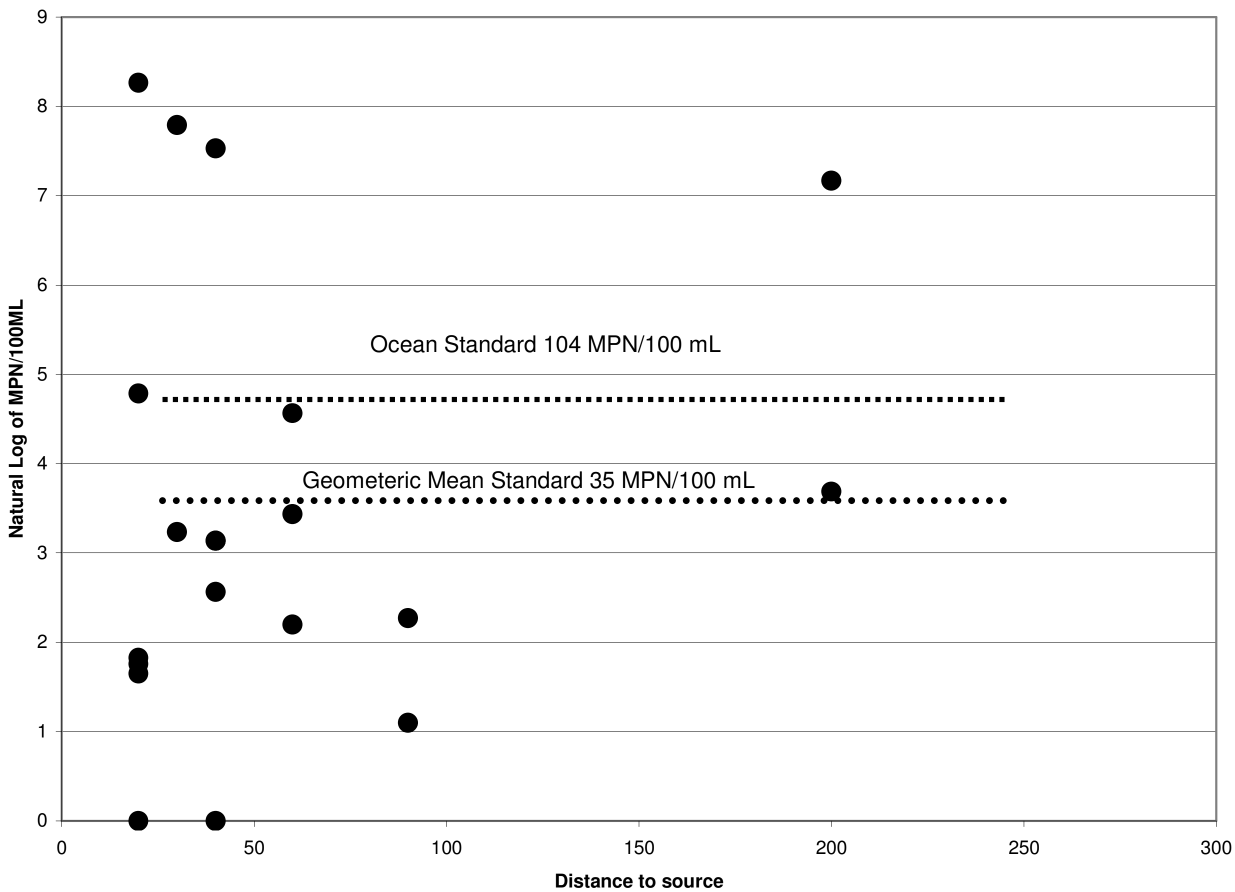
Table 1: End-of-Pipe Effluent Bacteria Densities MPN/100mL reported for permitted Malibu Civic Center Commercial Facilities <u>with Disinfection</u>. Highlighted measures are enterococcus values in human waste which exceed fecal and/or total bacteria counts or are above 35 Most Probable Number (MPN)/100 mL (geometric mean standard for beneficial use of body contract recreation (REC-1)).

Site	Total	Fecal	Enterococcus
Malibu Creek Preservation	1,600	350	46
	1,600	140	110
Malibu Beach Inn	Not measured	2	2
	Not measured	2	2
Malibu Colony Plaza	105	2	2
	4,000	2	2
	1,600	1,600	2,419
	1,600	1,600	2,419
Fire Station 88	1,600	1,600	2,419
	9,000	Not available	90,000
	24,000	24,000	24,000
	30,000	2,400	50,000
	240,000	Not available	240,000
	300,000	50,000	1,600,000

[1] All bacteria measures, even from the same waste stream, are highly variable. Enterococcus bacteria in end-of-pipe measures correlate with fecal (R^2 = .88) and total (R^2=.84) bacteria in those same samples.

An examination of maximum enterococcus densities in groundwater monitoring wells adjacent to nine permitted Advanced On-site Wastewater Disposal Systems in the Malibu Civic Center found that the groundwater bacteria densities are present at elevated levels and decrease from 10,000,000 MPN/mL to zero with distance from the subsurface discharge point to the monitoring well (Figure1).

Figure 1: Natural Log of Enterococcus in Groundwater Wells versus distance from the end-of-pipe in feet in the Malibu Civic Center (outliers at 200 feet distance are attributed to bacteria transport through fractures to the Malibu Administration Center, possibly from residential septic systems)



Elevated bacteria levels were found throughout the Malibu Valley groundwater basin which underlies the Malibu Civic Center area as reported in 2004 by Stone Environmental in "Final Report- Risk Assessment of Decentralized Wastewater Disposal Systems in High Priority Areas in the City of Malibu CA."(Figures 2a, 2b and 3). Large densities are seen adjacent to the receiving waters. Fifteen out of 20 wells in Stone 2004 Study and 16 out of 27 permit monitoring wells contained maximum enterococcus exceeding water quality objective of 104 MPN/100ml for beneficial use of REC-1, i.e., 31 out 47 wells (76% wells) have exceedance.

Figure 2a: Chart of Maximum Enterococcus MPN/100 mL for 20 groundwater wells in the Civic Center area from Stone 2004 Study (well locations are shown in Figure 3).

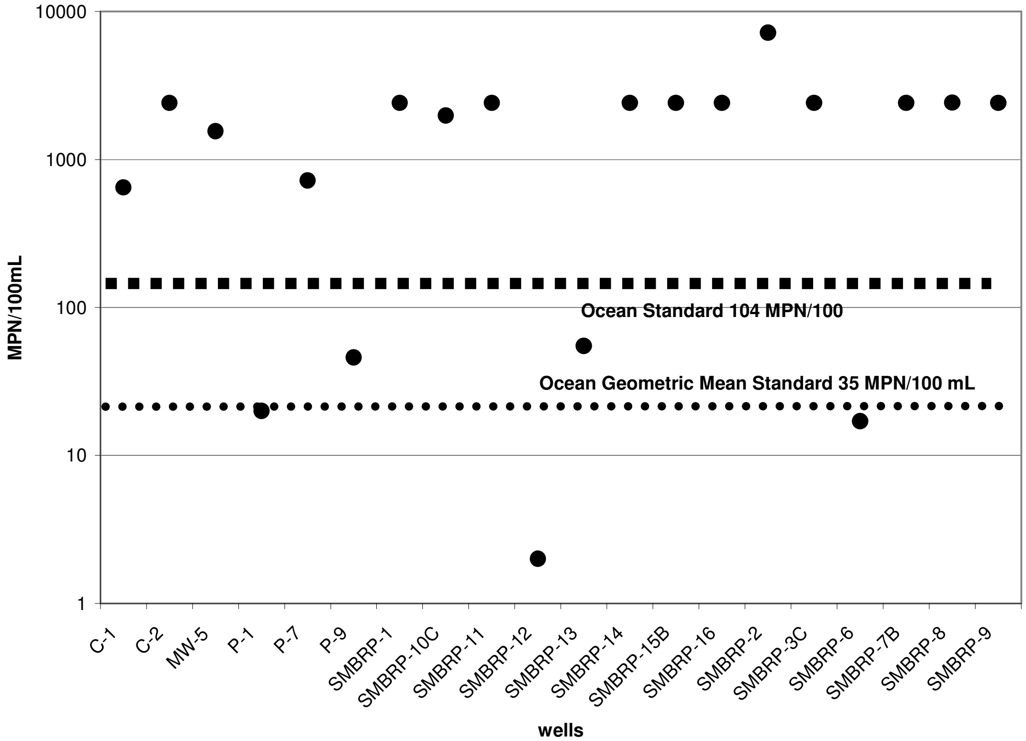


Figure 2b: Chart of Maximum Enterococcus MPN/100 mL for 27 permit monitoring wells in the Civic Center area (well locations are shown in Figure 1 of Technical memorandum #2).

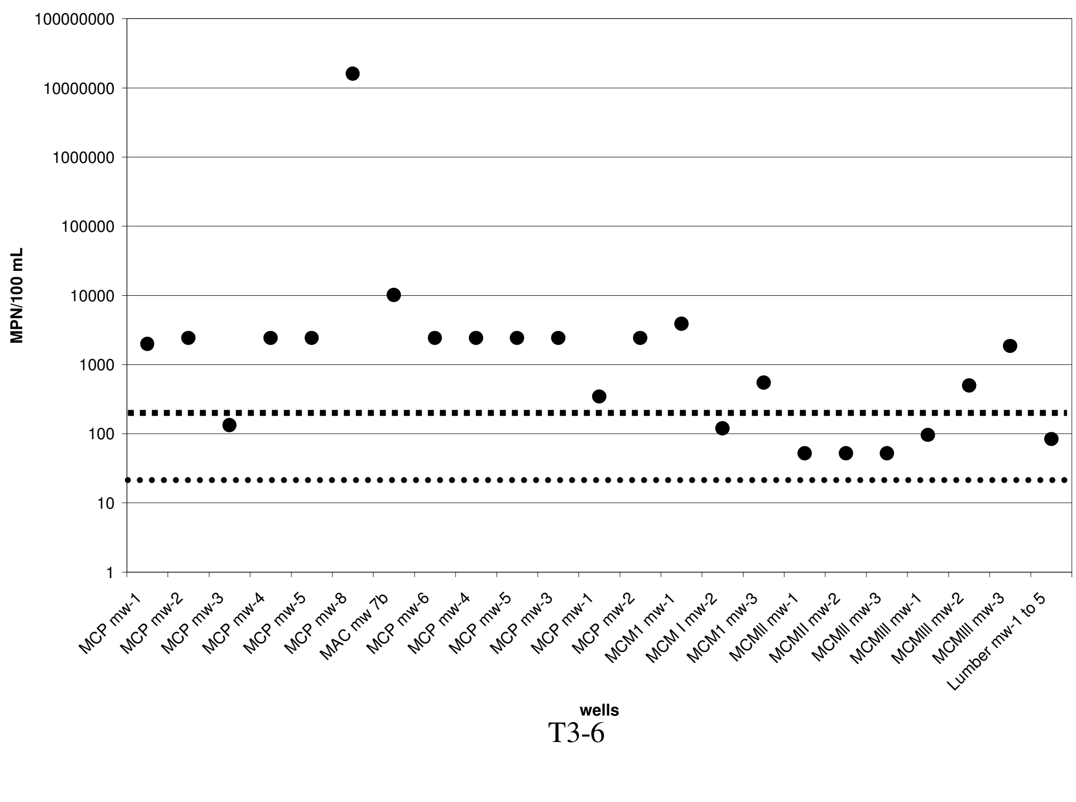
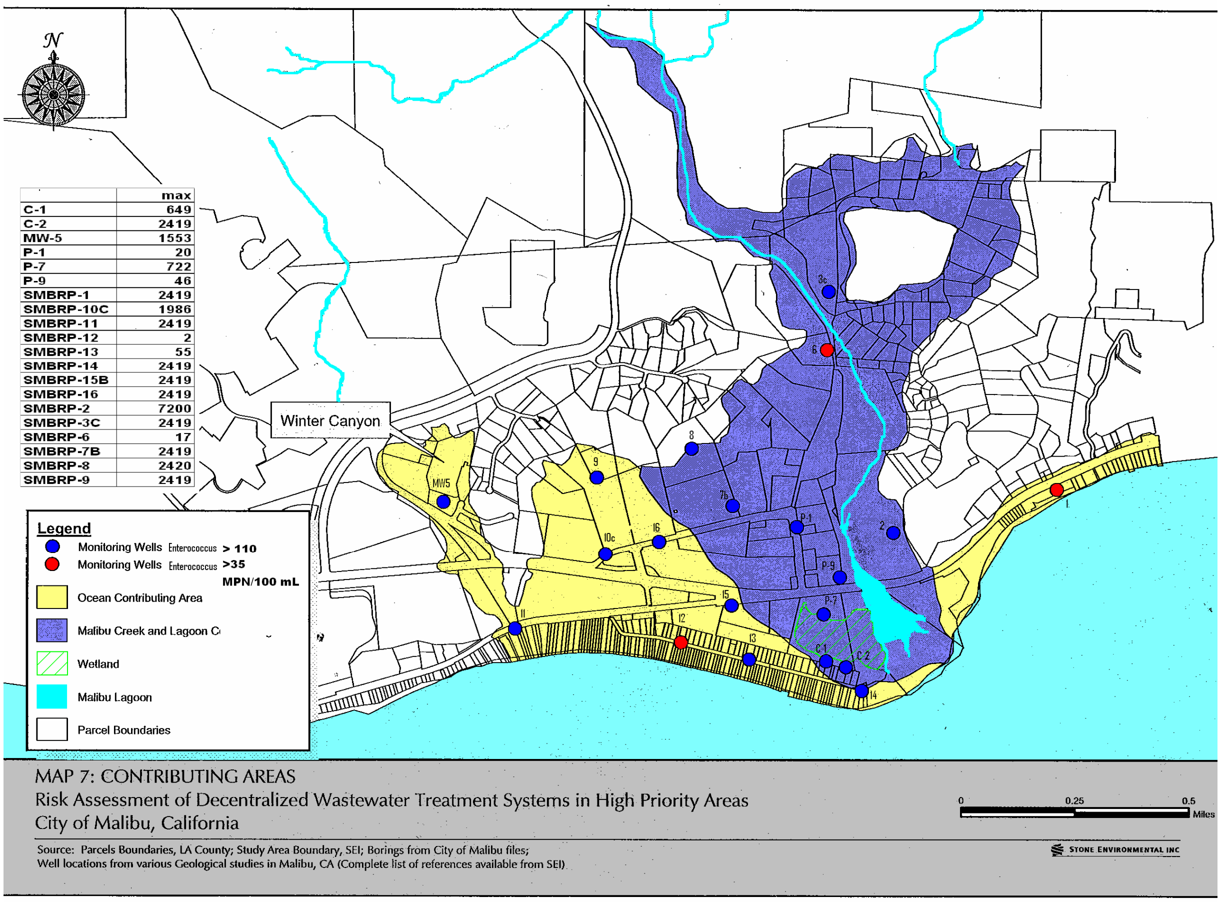


Figure 3 after Stone 2004 shows the <u>maximum</u> enterococcus measures in wells in the Civic Center area. (Densities above 104 MPN/100 mL are the darkest spots).



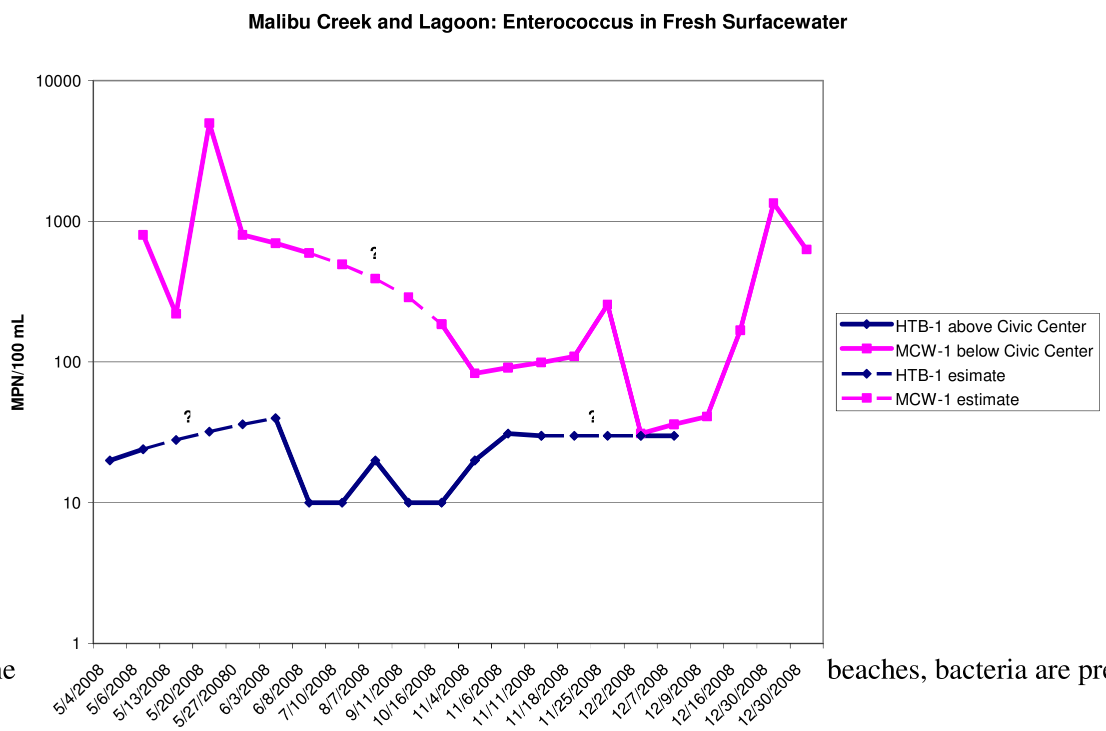
Bacteria in Surface Water

Summer levels of the fecal-indicator-bacteria enterococcus are not as high in the water entering Malibu Lagoon from the Malibu Creek watershed (see Figure 4), as they are downstream of the Malibu Civic Center area. The contrast can be seen in Figure 5 showing enterococcus at Lower Malibu Creek sampling station HTB-1 and Lagoon sampling station MCW-1. Some bacteria in surface water flows in the Malibu Civic Center may enter the surface water with summer groundwater discharge from the Malibu Civic Center area and result in higher enterococcus in the Lagoon. Further, the bacteria in the lagoon surface water must enter the groundwater beneath Surfrider Beach again before discharging into the wave zone at MC-2 as seen on the Figure 4 below.

Figure 4: Malibu Civic Center Surface water and Beach Sampling Points. (HTB-1 where surface water from Malibu Creek watershed enters the lagoon, MCW-1 where Malibu Creek enters Malibu Lagoon after receiving groundwater discharge from the Malibu Civic Center. Also see are beach sampling points MC-1 at the Beach adjacent to Malibu Colony, MC-2 at the breach point of Malibu Lagoon on Surfrider Beach, MC-3 at the beach adjacent to Malibu Pier and SMB-1-13 at Carbon Canyon Beach where Sweetwater Canyon discharges.)

The Malibu Creek and Lagoon TMDL also evaluated the bacteria levels in surface water and set loads for total bacteria which are less than the loads measured in 2004.

Figure 5: Enterococcus in Surface water at Malibu Civic Center



On the beaches, bacteria are present

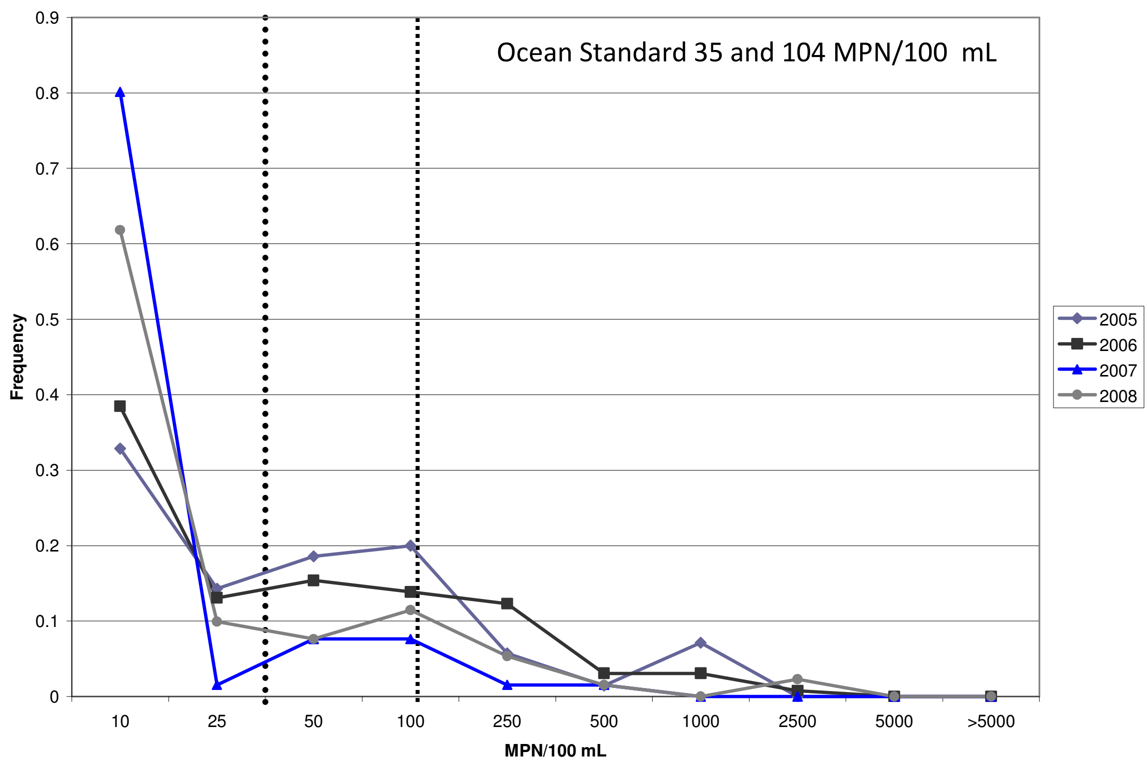
at levels above water quality objectives at Malibu Colony (MC-1), Surfrider Beach (MC-2), and Malibu Pier (MC-3). The pollution on beaches has been quantified in the 2003 303(d) list, Heal the Bay's beach quality grades, and the Regional Board's Santa Monica Bay Bacteria TMDLs. Further, the Regional Board issued a Notice of Violation (NOV) for bacteria at the Malibu Civic Center beaches in March 2008. It identified violations of the waste discharge requirements established in Board Order No. 01-182, as amended by Order No. R4-2006-0074 and Order No. R4-2007-0042, Board directions which constitute the Los Angeles MS-4 Permit controlling urban runoff and stormwater discharge. The NOV identified 493 days and 836 instances in the City of Malibu during the summer of 2007 when water contact recreation objectives were exceeded. Of these exceedances, seventy single sample violations occurred adjacent to the Malibu Civic Center.

Enterococcus on Malibu Civic Center Beaches and all Santa Monica Bay Beaches

The enterococcus measures recorded on beaches at the Malibu Civic Center area over the summers 2005 to 2008 were sorted by interval frequency and plotted against the percentage of the total number of measurements. The method was chosen to minimize the impact of varying sample sizes and simplify large variations in the measures.

The Civic Center beaches were found to have enterococcus frequency distributions with correlation coefficients which demonstrate that the distribution of bacteria frequencies is consistent at a beach, and not a function of external events such as swimmer shedding, the inappropriate disposal of a diaper or beach use by a homeless person.

Figure 6. Surfrider Beach MC-2 Enterococcus Interval Frequency for May-October Summer Single Measures (Correlation coefficients of the frequency distribution ranges from .82 to .99: see discussion in Attachment 3-1)



D R A F T J U L Y 3 1 2 0 0 9

Figure 7. Malibu Colony MC-1 Enterococcus Interval Frequency for May-October Summer Single Measures

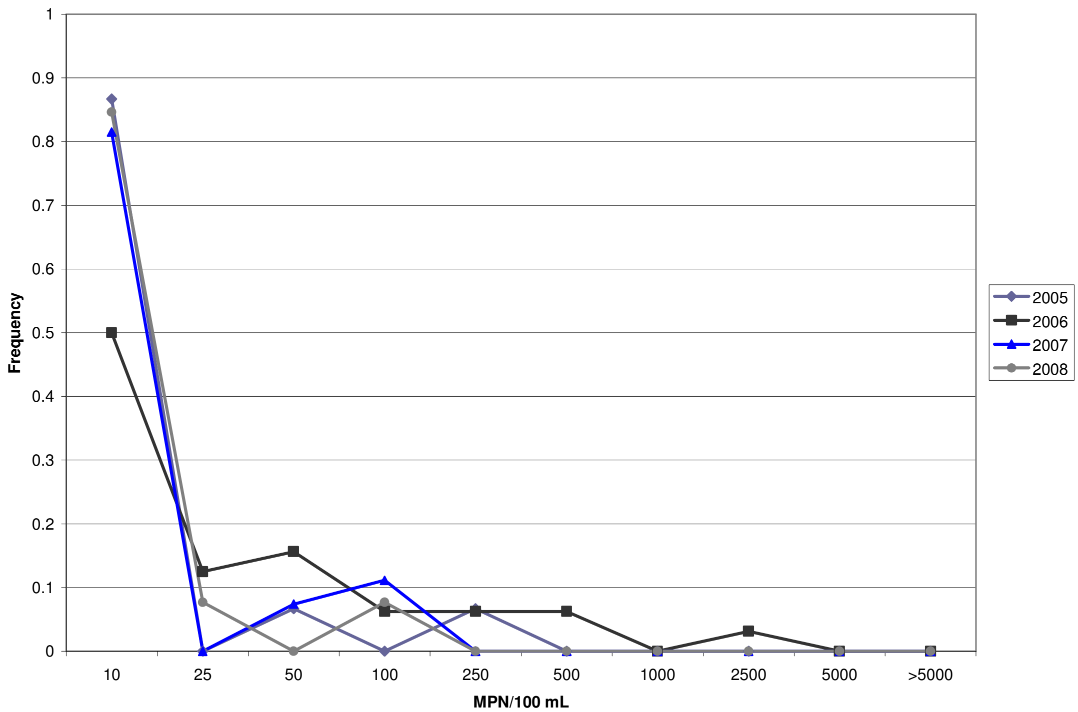
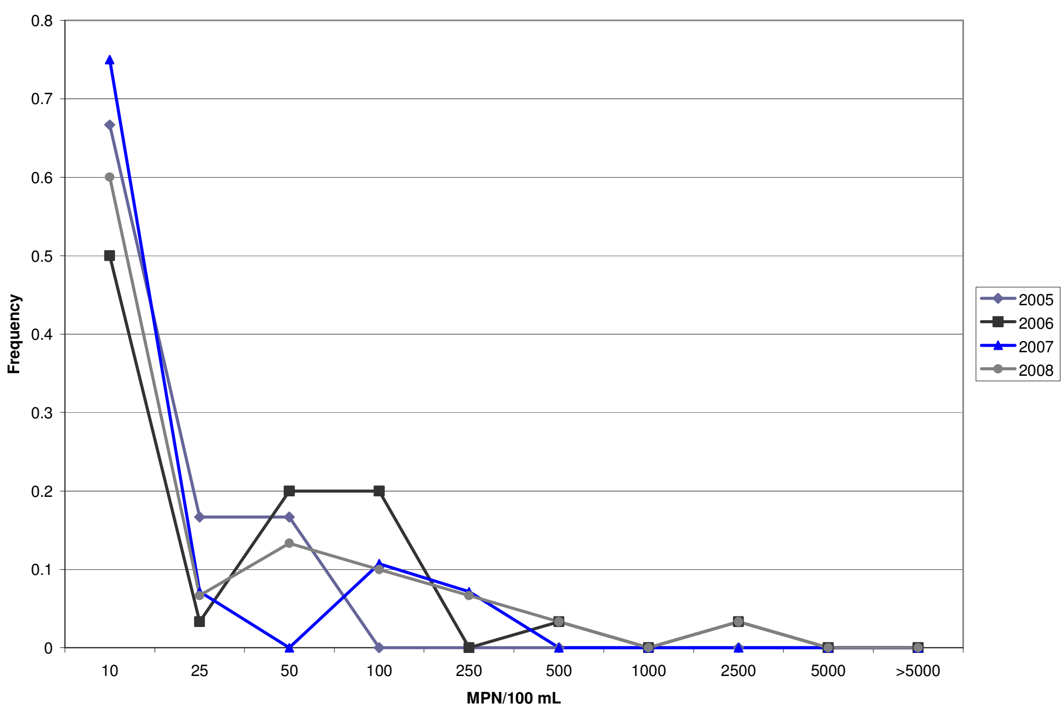
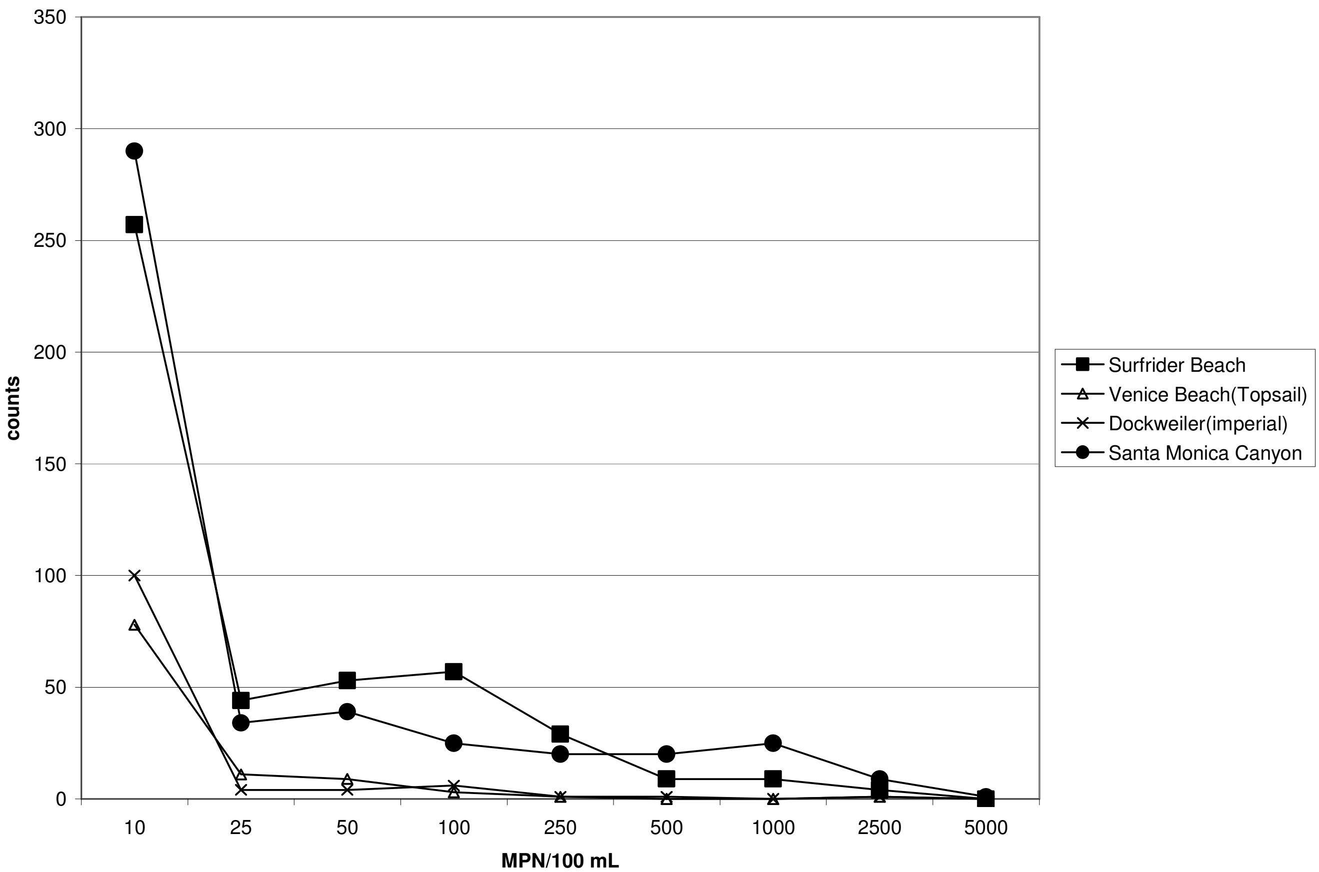


Figure 8. Malibu Pier MC-3 Enterococcus Interval Frequency for May-October Single Measures



The enterococcus interval frequency distribution at the Malibu Civic Center beaches (septic beaches) are both similar and distinct from those found for other individual beaches, as in this comparison of the septic Surfrider Beach and Santa Monica Canyon, Venice Beach at Topsail and Dockweiler Beach at Imperial, all of which are sewered. All four beaches are near to a freshwater discharge point for a large watershed area and have heavy public use. In this particular graph, values below 10 MPN/100 mL were not included and counts are displayed instead of frequency.

Figure 9. Surfrider, Santa Monica Canyon, Venice and Dockweiler Beaches Enterococcus Interval Counts for May-October Summer Single Measures for 2005-2008 without values <10 MPN/100mL



The Malibu Civic Center beaches were found to have enterococcus frequency distributions similar to those for all Santa Monica Bay Beaches in that they had the most measures at 10 MPN/100 mL and some additional measures above 1,000 MPN/100 mL. Figures 10-13 and Tables 4-7 of all Santa Monica Bay beaches for 2005 through 2008 show that these general characteristics are present for all the studied beaches.

Figure 10. 34 Santa Monica Bay Beaches 2005 (All MS-4 beaches without direct ocean discharge to waves) Enterococcus Interval Frequency for June-August Single Measures

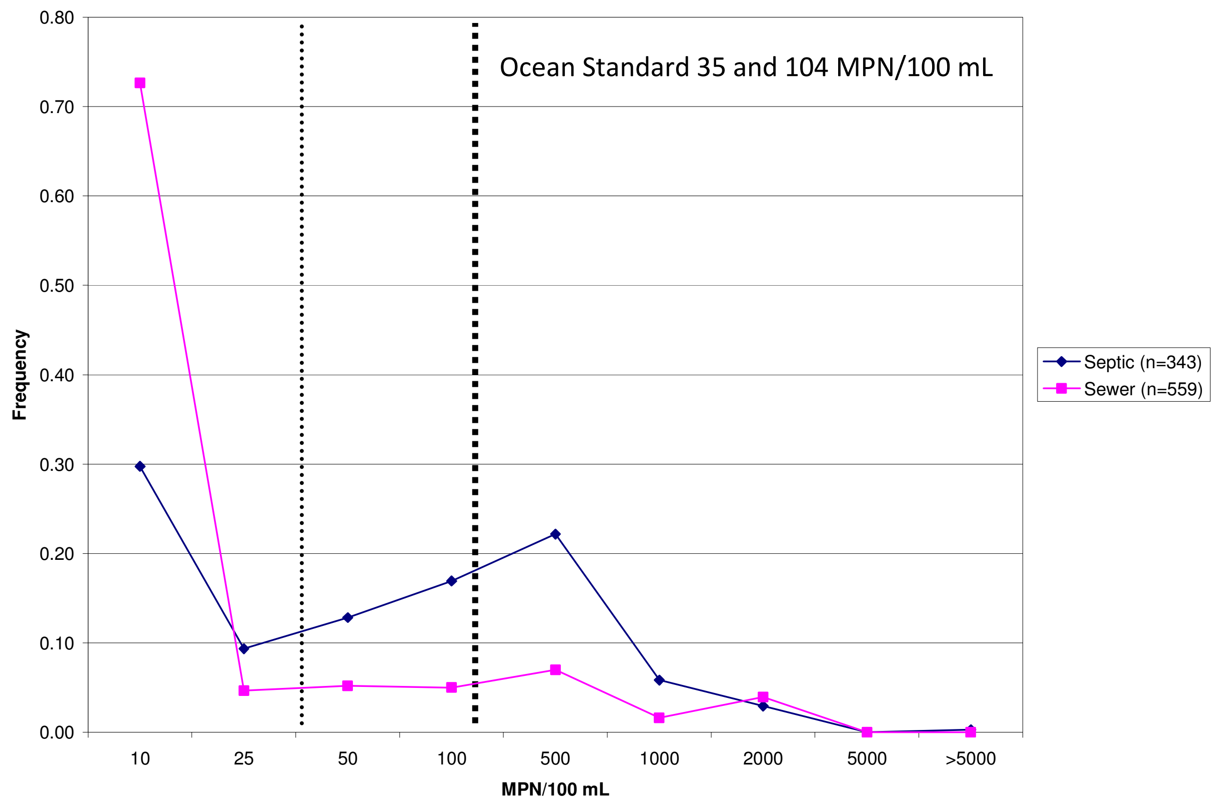


Table 4: Relative Number of Exceedances for 58 Septic and Sewered Beaches in 2005.

In MPN/100mL	all beaches in 2005			
Enterococcus	Septic (n=466)	% total days reported at septic sites	Sewer (n=859)	% total days reported at sewer sites
Days above 35	206	44%	207	24%
Days above 104	108	23%	126	15%

Figure 11. 34 Santa Monica Bay Beaches 2006 (All MS-4 beaches without direct ocean discharge to waves) 1nterococcus Interval Frequency for May-October Single Measures

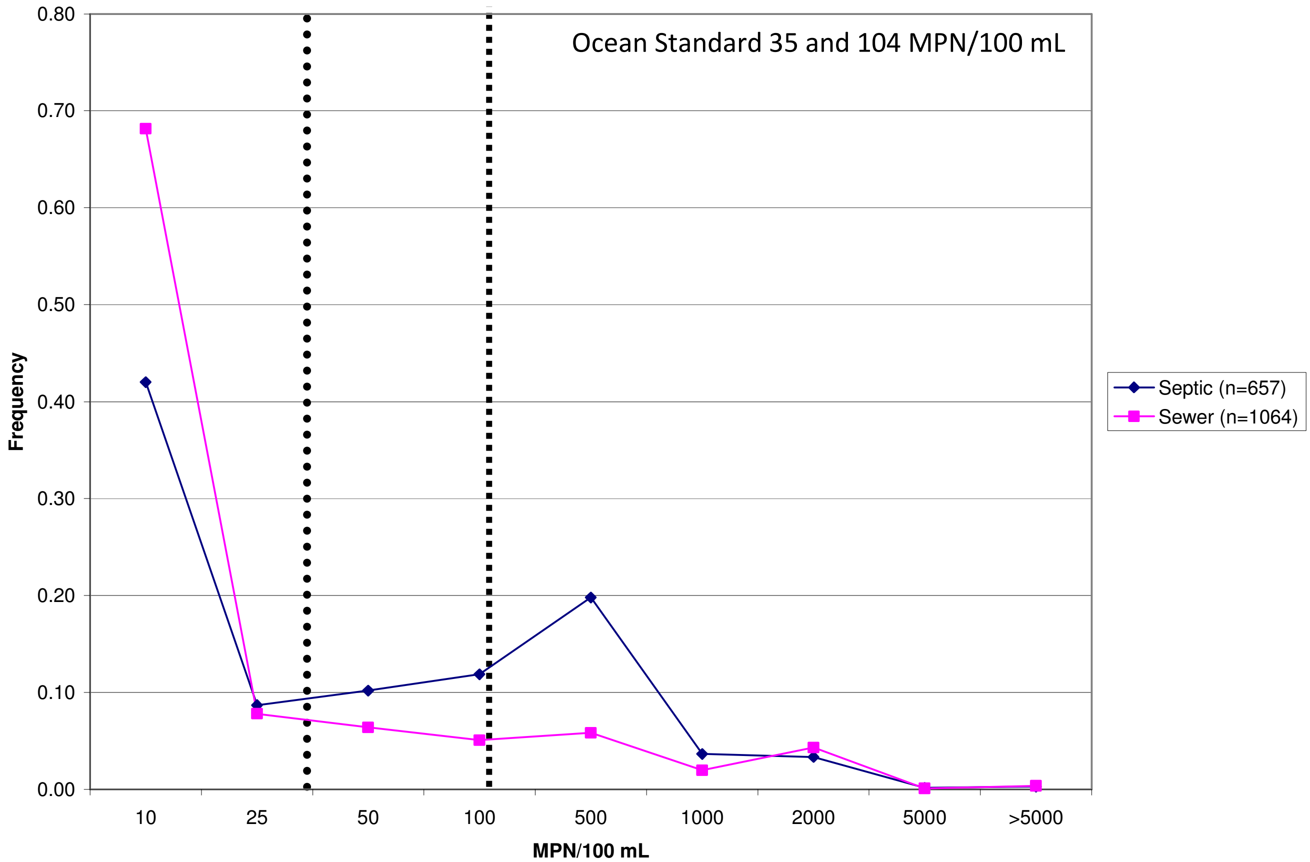


Table 5: Relative Number of Exceedances for 58 Septic and Sewered Beaches in 2006. Sewered beaches were tested about one and a half times as often, in this year, as septic beaches, yet more days were recorded when enterococcus densities on septic beaches were higher than the Ocean single sample and geometric mean objectives.

In MPN/100mL	all beaches in 2006			
Enterococcus	Septic (n=903)	% total days reported at septic sites	Sewer (n=1669)	% total days reported at sewer sites
Days above 35	326	36%	295	18%
Days above 104	183	20%	156	9%

Figure 12. 34 Santa Monica Bay Beaches 2007 (All MS-4 beaches without direct ocean discharge to waves) Enterococcus Interval Frequency for May-October Single Measures

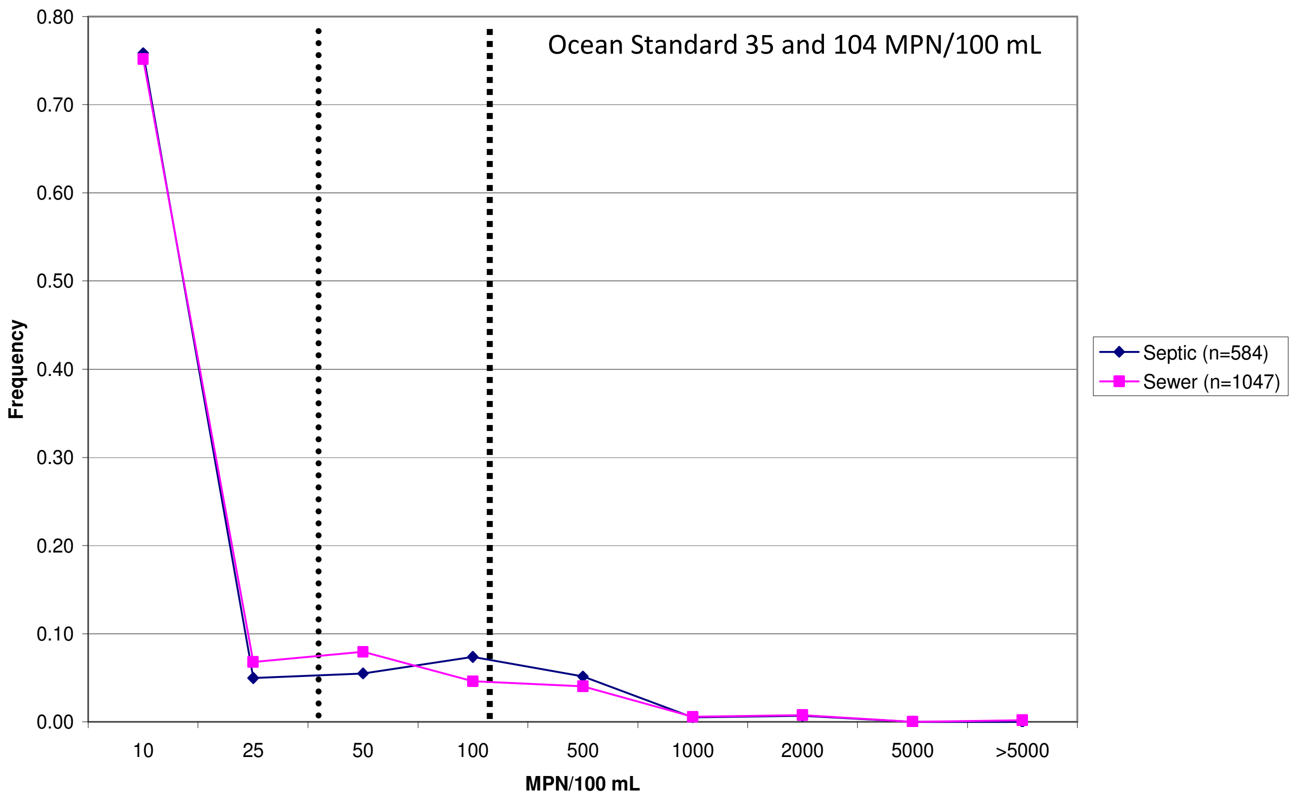


Table 6: Relative Number of Exceedances for 58 Septic and Sewered Beaches in 2007. Sewered beaches were tested about twice as often, in this year, as septic beaches, and both had the same frequency of exceedances.

In MPN/100mL	all beaches in 2007			
Enterococcus	Septic (n=816)	% total days reported at septic sites	Sewer (n=1705)	% total days reported at sewer sites
Days above 35	106	13%	215	13%
Days above 104	38	5%	79	5%

Figure 13. 34 Santa Monica Bay Beaches 2008 (All MS-4 beaches without direct ocean discharge to waves) Enterococcus Interval Frequency for May-October Single Measures

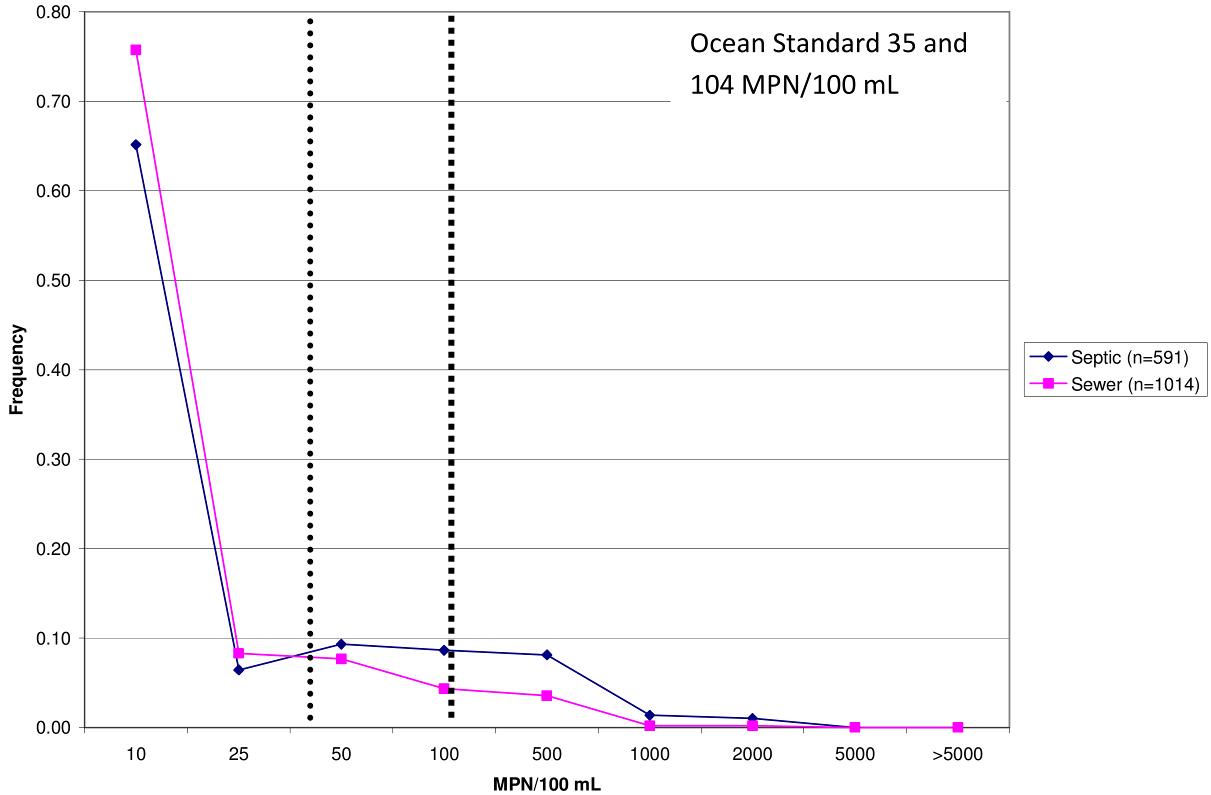


Table 7: Relative Number of Exceedances for 58 Septic and Sewered Beaches in 2008.

In MPN/100mL	all beaches in 2008			
Enterococcus	Septic (n=813)	% total days reported at septic sites	Sewer (n=1644)	% total days reported at sewer sites
Days above 35	145	18%	176	11%
Days above 104	59	7%	54	3%

This general comparison between Civic Center Beaches and all Santa Monica Bay beaches is consistent with the hypothesis that the mechanism(s) supplying enterococcus bacteria to beaches during the summer months does not operate uniformly every year. Further, the mechanism which supplies enterococcus bacteria to the beaches at levels of 10 MPN/100 mL, and to a lesser extent at levels above 1,000 MPN, must operate on all beaches regardless of the year or the method of waste treatment in the adjacent area.

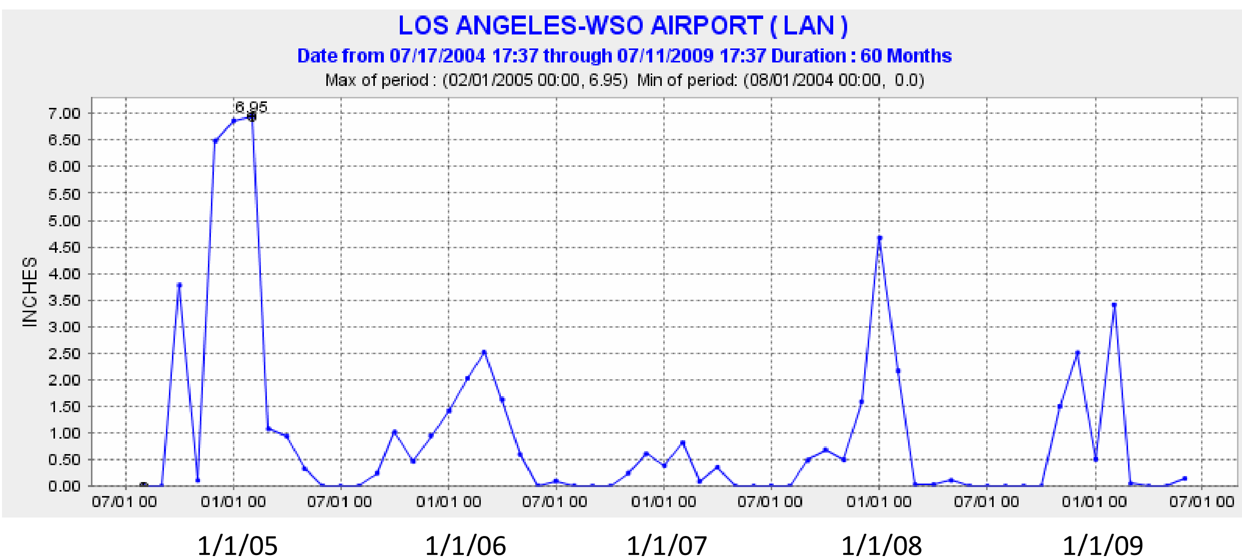
Statistic analysis is performed for the same data sets of 2005-2008 using Gehan Test (a non-parametric Statistical Program) from USEPA ProUCL Statistical Program. All results confirmed hypothesis that enterococcus concentrations at septic beaches are greater than sewered beaches with 95% confidence level except 2007 data. Gehan Test results are included in Attachment 3-1. *Rainfall and Bacteria*

Examination of all Santa Monica Bay beaches over four years provides evidence that bacteria are transported by groundwater to the beach face. Because bacteria must be transported by the groundwater between the septic systems and surface receiving waters and groundwater gradients increase after rain, a correlation between the number of enterococcus measures per site and the rainfall is expected at beaches where groundwater movement of the bacteria takes place.

Rainfall and Enterococcus

The highest monthly volume of rain fell in 2005 (wet year), among the years evaluated here, when 6.95 inches were recorded. The lowest was reported in 2007 (dry year) when less than one inch was recorded. However, the average annual rain fall in this area is 12 inches per year, significantly larger than the rain received in this study's "wet" year of 2005. Rain gauge reports from Los Angeles International Airport reported by the Department of Water Resources confirm annual variations in precipitation by year and are shown in Figure 14.

Figure 14. Rain gauge information for Los Angeles International Airport (elev.100 feet)



Septic beaches are more distinct from sewered beaches in summers preceeded by rainy winters. The relative frequency of bacteria densities above 35 MPN/100mL on the beaches during the summer are seen to decrease between 2005 and 2007 in Tables 4 through 6. The rainfall also decreases during this period as shown in Figure 14.

Non parametric statistical tools were applied to the enterococcus beach data sets using Gehan Test from EPA's ProUCL statistical program. Using Form 1 Test, the Null Hypothesis is "Septic Beach

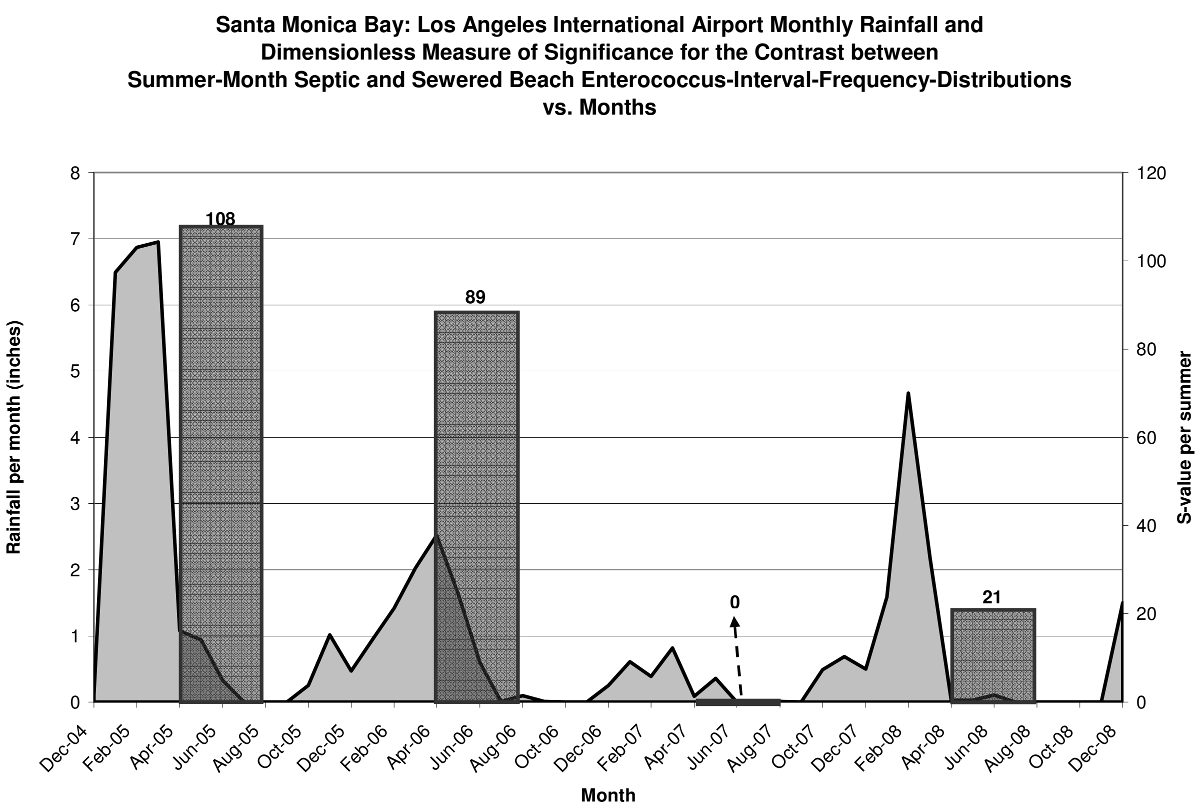
Mean/Median Less Than or Equal to Sewer Beach Mean/Median;" and the Alternative Hypothesis is "Septic Beach Mean/Median Greater Than Sewer Beach Mean/Median". The result of the Gehan Test for 2005, 2006 and 2008 shows that the Null Hypothesis is rejected by a low P-value with an alpha value of 0.05 (a confidence level of 95%) , which rejects the Null Hypothesis and supports the Alternative Hypothesis "Septic Beach Mean/Median Greater Than Sewer Beach Mean/Median".

The statistical assessment of the 2007 enterococcus data is not consistent with the statistical results for 2005, 2006, and 2008. The same results were also obtained with an alpha value of 0.01 (a confidence level of 99%); enterococcus concentrations at septic beaches are higher than concentrations at sewered beaches statistically. Form 2 Test is also performed using the Gehan Test to verify the above conclusions.

The "Substantial Difference" (S) is used to estimate the difference in enterococcus concentration between septic and sewered beaches and is shown in Figure 15. The rainfall was low in 2007, as is the S value. The S increases as the winter rains increase in 2008.

Because septic or sewered beach have no stormwater discharge for June to September, these observations document a supply and transport mechansim. Ground water discharge with elevated enterococcocus densities after wet winters is affecting septic beaches to a greater extent than is occuring on sewered beaches. In the summer of 2008, the frequency of enterococcus densities above 35 MPN/100mL does not increase to the 2006 summer levels, despite increasing rainfall in the winter of 2007-2008, nor does the S value increase to 2006 levels. This observation is attributed to short term rain events in February 2008 when discharge was via stormwater and not groundwater recharge..

Figure 15.



* For a discussion of the S value see Attachment 3-1 on statistics.

The number of violations of the Ocean Plan enterococcus objectives, as reported in the 2008 Notice of Violation sent to MS-4 Stormwater dischargers based on the Santa Monica Bay Dry Weather Bacteria Total Maximum Daily Loads, is higher at Civic Center Beach than at beaches with shared physical characteristics. The exception is Santa Monica Pier. It had fewer geometric mean enterococcus exceedances than Malibu Pier and even single sample enterococcus is less likely to be a human-fecal-indicator as summarized in Table 8. In general, septic beaches have higher exceedance of water quality objectives than sewered beaches when similar individual beach data sets are compared.

Table 8: Failure to meet Ocean Standards at Civic Center Beaches and paired beaches

Fecal Indicator Bacteria Violations for Civic Center Beach	Paired Beach	Single Total	Single Fecal	Single Enter	30 day Mean Enter	Objective not achieved	Total Days objective not achieved
Surfrider (MC-2)		7	25	**9**	**8**	132	62
	Santa Monica Canyon(2-7)	0	1	8	0	10	10
	Venice beach Topsail (2-9)	0	0	0	0	0	0
	Dockweiler Imperial (2-13)	1	0	0	0	1	1
Malibu Colony (MC-1)		0	1	**0**	**13**	19	14
	Will Rogers east of Sunset (2-3)			3	3		
	Santa Monica Beach at strand (3-9)			0	0		
	Hermosa Beach at 26th (5-4)			1	1		
Malibu Pier (MC-3)		0	0	**3**	**16**	20	19
	Santa Monica Pier (3-3)	4	96	**15**	**13**	424	236
	Redondo Beach Pier (6-2)			2	2		
	Hermosa Beach Pier (5-5)			1	1		

D R A F T J U L Y 3 1 2 0 0 9

Human Health Risk from Enterococcus on Civic Center Beaches

A specific measure of the human health risk with enterococcus density is based on an epidemiology study (Cabelli, V.J, 1983 EPA health criteria for enterococcus density in marine recreational waters) which correlates fecal-indicator-bacteria enterococcus, a bacteria species found in the human gut, and increased rates of gastrointestinal illness (flu symptoms) among swimmers who immersed their heads**.** Some of the beaches studied had identifiable sources of treated or untreated human waste entering the marine environment in the vicinity of the beaches, and some did not. All had urban runoff, storm flow and human visitors during the study period.

The swimming-associated gastroenteritis examined in the study is acute, is of short duration and children have the highest attack rates. The symptoms quantified were fever, vomiting, diarrhea, stomachache, and nausea. EPA proposed human rotavirus and/or the parvo-like viruses as etiologic agents. The researchers find "..the etiologic agent(s) for the observed GI [Gastrointestinal] symptomatology is present in sewage in large numbers, that it is highly infective and/or that it survives sewage treatment, disinfection, and/or transport better than the indicator [enterococcus] (page 44)."

EPA counted the immersed-head swimming and non-swimming populations, their highly credible gastrointestinal illness rates and the enterococcus density in the chest-depth water. They found a linear relationship between the swimming associated rate for gastrointestinal symptoms for 1,000 people and enterococcus bacteria density, a relationship depicted for frequency interval in Table 9.

Table 9. Enterococcus Densities and Illnesses among Swimmers

1983 EPA Health Effects Criteria for Marine Recreational Waters (Figure 9, page 43)						
MPN/100 mL	10	50	100	250	500	1,000
Number of illnesses per 1,000 swimmers	9	23	30	40	46	53

Where enterococcus densities are measured and EPA's other assumptions apply, the risk of illnesses per 1,000 swimmers can be estimated using this relationship. If the interval frequencies of enterococcus densities are calculated for a beach over a summer, then that interval frequency (F) at the Santa Monica Bay beaches times the number of illnesses corresponding to the average MPN/100 mL of the interval (N), from the EPA study quantifies the risk (R) as estimated in the number of illnesses in 100 summer days if 1,000 swimmers swim each day.

F (Frequency for range of MPN/100mL) **X** **N** (Number of illness for average MPN/100ML) **= R** (Risk or number of illnesses).

EPA's criteria have been applied to enterococcus bacteria delivered in stormwater flow across a beach into the Santa Monica Bay, similar to the river influent cases in New York. It has also been applied where no surface flow exists between the influent drain or river and the beach monitoring site, like the case in

Boston Harbor, where increased enterococcus densities are related to transport of bacteria from the Ocean or through the beach subsurface.

Since the EPA criteria were developed, some authors (Yamahara, 2008) have questioned its application where an ocean outfall of untreated or partially treated sewage is not present. The EPA study is used here because the illness rates were also based on beaches with no identifiable source of human sewage.

Human viruses, have been found in Malibu Lagoon and Ballona Creek as described in Dr. Mark Gold's 1994 thesis. The source of the viruses are identified as urban flows/stormwater and septic discharge. An elevated risk that enterococcus bacteria indicate human fecal pathogens and viruses could be inferred to exist at beaches adjacent to septic systems, receiving surface flows which discharge directly into the wave wash, and adjacent to discharging ground water in which human enterococcus is identified and attributed to septic discharge. Table 10 below is based on 2006 data and combines the EPA risk as defined solely by enterococcus frequencies and illnesses among swimmers and an estimated additional risk factor that the enterococcus measured on the beach is associated with human fecal pathogens or human viruses. Selected beaches are ranked by the presence of (a) year-round overland flow across the beach of storm/urban flow like Ballona Creek where human viruses were identified , (b) septic systems within 300 feet of the tributary channel or the beach like Malibu Lagoon where the viruses were found, or (c) groundwater concentrations of enterococcus above 1 MPN/ 100 mL within 300 feet of the tributary or channel adjacent and related to leach field discharge of human waste. A ranking of 'High' means that all of these factors are present, a ranking of "Moderate" means that two of these factors are present, and a ranking of "Low" means that one of these factors is present. "None" means that none of these factors are present.

The beaches adjacent to the Malibu Civic Center show the highest combined risk based on possible illness related to enterococcus levels and an increased likelihood of the presence of human fecal pathogens and viruses.

Table 10: Combined Measures of Risk for Human Health- individual Santa Monica Beaches (2006).

Site	**1983 EPA health risk (Additional illnesses)**	**Additional risk factors for human enterococcus***	
SMB 1-12	43	High	Marie Canyon Stormdrain on Puerco Beach
SMB 1-07	27	High	Ramirez Canyon at Paradise Cove Pier
SMB MC-02	22	High	Breach of Malibu Lagoon/Malibu Beach
SMB MC-03	20	High	Malibu Pier on Carbon Beach
SMB MC-01	19	High	Malibu Point on Malibu State beach
SMB 1-10	24	Mod	Solstice Creek at Dan Blocker Beach
SMB 1-18	21	Mod	Topanga Canyon on Topanga State Beach
SMB 2-07	17	Mod	Santa Monica Canyon ##
SMB BC-01	13	Mod	Ballona Creek##
SMB 1-08	27	Low	Escondido Creek
SMB 1-09	19	Low	Latigo Canyon
SMB 3-03	18	None	Santa Monica Pier Stormdrain/Beach##
SMB 5-02	17	None	28th Street Drain, Manhattan Beach##
SMB 3-04	12	None	Pico-Kenter Storm Drain##

*risk factors are (a) groundwater enterococcus levels above 1 MPN/100mL, (b) adjacent septic systems, and (c) surface flow across the beach face. ## sewered beaches. Enterococcus levels were not found to correlate with increasing watershed size among MS-4 beaches and were not found to correlate with other possible sources of human enterococcus such as beach attendance or with possible elevated rates of enterococcus preservation such as low wave strength (Yamahara 2007).

Risk at Septic Beaches compared to Risk at Sewered Beaches

A comparison of estimated illness risk for 13 septic and 21 sewered beaches[2], using only the EPA criteria and the MS-4 interval frequency curves for the wettest summer of 2005 results in a risk of 22 illnesses among swimmers for all septic beaches and a risk of 16 swimmer illnesses for all sewered beaches for 100 days with 1000 swimmers at all beaches or 10,000 swimmers at all Santa Monica Bay beaches over 10 days.

For 2006, 22 illness are predicted for 13 septic beaches for every 1000 summer swimmers and 16 for 21 sewered beaches for every 1000 swimmers. While the illness risk for 2007 is the same, the risk of illness in the wet year of 2008 is 15 for septic beaches and 13 for sewered beaches.

This risk calculation assumes that human viruses are equally likely to be indicated by enterococcus at all beaches. More human illnesses are expected at septic beaches because the supply of human fecal material is larger, as described above based on 2005 to 2008 data.

Waste Discharge Treatment and Human Health Risk

About 300 Malibu Colony residences can be counted from aerial photo interpretations after 1955 on US Geological Survey topographic maps at a beach bar with 6,000 feet of ocean front. The width of the developed area of the Colony is estimated at 500 feet for a total area of 3,000,000 square feet. Because 43,560 square feet constitutes an acre, the septic density for Malibu Colony is about 4 septic systems per acre.

Septic systems have been shown to discharge to the surface in the vicinity of the leachfields/seepage pits and this process has been linked to increased illness in children. As a result, increased septic system density is also related to an elevated human health risk. In M.A. Borchardt et.al**.**, "Septic System Density and Infectious Diarrhea in a Defined Population of Children" in May 2003 (*Environmental Health Perspectives* Vol. 111, No. 5), an 8% increase in the risk of viral diarrhea illness was associated with an additional septic holding tank per 640 acres and a 20% increase in bacterial diarrhea was related to an additional septic holding tank in 40 acres. For reference, the density of septic systems in Malibu Colony is much higher, about 4 per acre. The author states "consumption of well water was not a likely transmission route of bacterial infection from nearby septic systems in this study, because bacterial pathogens were not isolated from the wells of case households, although contamination may have been sporadic."

In contrast, a high level of effectiveness of sewage treatment in centralized treatment plants has been developed through best management practices (Allen 1949), the National Pollution Discharge Elimination

[2] For the purposes of this study, the following site definitions were made: MS-4 Septic (13)1-06, 1-07, 1-08, 1-09, 1-10, 1-11, 1-12, 1-13, 1-18, 4-01, MC-01, MC-02,MC-03; MS-4 Sewer (21) 2-01, 2-02, 2-06, 2-07, 2-10, 2-11, 2-13, 2-15, 3-01, 3-02, 3-03, 3-04, 3-05, 3-06, 3-07, 3-08, 5-02, 5-03,6-01,6-05,BC-01; Non MS-4 Septic (9)1-01,1-02,1-03,1-04,1-05,1-14,1-15,1-16,1-17; Non MS-4 Sewer (15) 2-03,2-04,2-05,2-08,2-09,2-12,2-14,3-09,5-05,5-04,5-05,6-02,6-03,6-04,6-06

System and the State of California's Title 22 regulation. State and Federal regulations now require that when treated sewage is discharged in large quantities (above 50,000) gallons per day, viruses must be 99.9% deactivated by ultra violet or chlorine disinfection before possible human contact is allowed. Even advanced on-site wastewater disposal systems in the Malibu Civic Center area have high failure rate of disinfection as shown in Table 1.

4. Discussion of Historic and Recent Studies

Historic Studies relating Malibu Civic Center Septic Systems to Human Health Risk and Beach Pathogens

Existing technical studies (summarized in Table 11) link septic systems at the Malibu Civic Center area to beach bacteria and are discussed below:

On February 5, 1970, Los Angeles County Health (now California Department of Public Health or CADPH) provided a letter to the Regional Board stating that serious potential hazards to human health were expected to result from septic systems. CADPH has repeatedly closed Surfrider Beach at the Malibu Civic Center due to high bacteria concentrations.

On July 8, 1987, Los Angles County Public Works held a public meeting to discuss a Draft Environmental Impact Report for a centralized waste water treatment plant and sewer for Malibu to address human health risk caused by septic system pathogens. The City of Malibu subsequently incorporated and a group of citizens brought a lawsuit to block the formation of assessment districts. The legal settlement required the new City of Malibu to provide sufficient oversight of on-site waste water treatment facilities such that they would meet Regional Board requirements.

The 1994 Ph.D. thesis of Dr. Mark Gold "What are the health risks of swimming in the Santa Monica Bay?" identified human viruses in Malibu Lagoon and identified a source of the contamination as adjacent septic systems.

On December 12, 2002, the Regional Board adopted a Resolution amending the Santa Monica Beach bacteria TMDL to the Basin Plan. The staff report found that bacteria loads from septic systems contribute to beach pathogens.

On August 30, 2004, the Stone report found that bacteria in the groundwater may enter receiving water where septic systems are found within 6 month groundwater travel time of the Ocean or Malibu Creek.

The September 17, 2004, Memorandum of Understanding between the City of Malibu and the Regional Board stated that "ordinances shall be drafted by staff, and recommended for adoption within the six-month-time-of-travel zone, as identified in the Risk Assessment Report (Stone), to provide advanced treatment and disinfection. The six-month time-of-travel zone shall include all areas contributing to Malibu Creek and Lagoon, and beaches between Sweetwater Canyon outfall and Winter Canyon outfall. OWTS located outside of the six-month-travel-time zone that cannot demonstrate compliance through inspection or that are identified as impacting groundwater by any other means shall provide adequate vertical separation and/or advanced treatment with disinfection." As of the date of this document, the City of Malibu has not provided documentation that systems within the six-month-time-of-travel zone have been upgraded to prevent bacteria discharge to the subsurface or include disinfection, nor has an ordinance to this effect been passed by the City of Malibu.

On Dec. 13, 2004, the Regional Board adopted a Resolution amending the Malibu Creek and Lagoon Bacteria TMDL to the basin plan. The staff report references a surface water model prepared by Tetra Tech which quantifies bacteria loads provided by septic systems in the Malibu Civic Center.

Numerous studies have been completed to describe the ecosystem, hydrology, land use, possible mechanisms of waste water treatment, and costs to support of policy decisions about bacteria and human health risk in the Malibu Civic Center (Ambrose et. al. 2008; Bing Yen and Associates, 2001; Crawford Multari and Clark Associates, 1997, 2006, 2007; Ensitu Engineering, 2008; Gold, 1994; Jones and Stokes, 2008; REGIONAL BOARD, 1972, 1998, 1990, 2002, 2004b, 2008, 2008b; Lucero, 2008; Warshall, 1992; Questa, 2003; RMC, 2008; SMBRP, 1999, 2001; UCLA, 2000; URS Greiner, 1999; EPA, 2003; Stone, 2004a, 2004b, 2004c; Trim, 1994; Thorsen, 2008; and Van Beveren, 2008a, 2008b, 2008c).

Table 11: Historic Findings of Human Health Risk related to Malibu Septic System Use.

Date	Source	Summary
Feb 5, 1970	LA County Flood letter to Regional Board	Future septic systems will pollute groundwater in Malibu Creek with nutrients
Feb 5, 1970	LA County Health (now CA DPH) to Regional Board	Serious potential hazard to health from septic systems
Feb 11, 1970	CA DWR to Regional Board	Malibu Valley needs an area wide Water Quality plan
Apr. 8, 1970	Public Hearing SWRCB	Discontinue septics, continue Regional Board surveillance
Jan. 21, 1971	CA DPH Status Ocean and streams in Malibu	Local ocean and freshwater bacteria exceed shell fish collection in areas of development
Mar. 12, 1971	Regional Board EO to LA County Supervisors	Sewer for Malibu must be provided
May 31, 1972	Regional Board Resolution 72-4	Waste Discharge Requirements only allowed if a timetable is established to provide future connections to LA County sewer
Apr. 10, 1985	CA DPH to LA County Supervisors	Staff report and recommendation to authorize Sewer districts
July 8, 1987-Nov. 30 1988	LA Public Works Public Meeting and Malibu Citizens Committee public meetings	Draft Environmental Impact Report for Sewer, discussion of Malibu incorporating, discuss alternatives for centralized system with wetland treatment
Jan. 18, 1989	LA County Supervisors hearing	STEP WWTP system construction approved

1992	Warshall et. al. report finalized	Septic systems in Malibu described. Pathogen removal quantified. Author states that systems require extensive management and recommends centralized system in some areas like Civic center
1994	Thesis Dr. Mark Gold	Three studies between 1990 and 1992 show high fecal-indicator-bacteria frequencies at ankle-depth wave wash and human viruses in runoff from three storm drains in Santa Monica Bay.
Dec. 14, 1998	Regional Board Resolution 98-023	Directs Report of Waste Discharge for all septics and ACL to City of Malibu
Aug 12, 1999	Regional Board Resolution 99-13	El Rio Septic staff report: Poorly maintained septics linked to nitrogen contamination in groundwater
1999	Dames and Moore study	Salt tracer, no pathogens found in wells within 200 feet, but tidal reversal confound results
1999	URS Greiner study	Salt Tracer found at 20 feet in wells, but pathogens not seen in short period test.
Dec. 12, 2002	Regional Board Resolution	Santa Monica Bay bacteria Total Maximum Daily Load: beach pathogens attributed to loads from septic systems
March 21, 2003	EPA Malibu Creek Nutrient TMDL	Total Maximum Daily Load sets loads and numeric targets for total Nitrogen
2003	Questa study	Groundwater discharge to receiving water, quantified including volume from septic system discharge.
Aug 30, 2004	Stone study	Bacteria may enter receiving water where septic systems are found within 6 month travel time
Dec. 13, 2004	Regional Board Resolution	Malibu Creek and Lagoon TMDL: Tetra Tech surface water model sets loads for bacteria from septic systems
March 2006	Richard Viergutz, M.S. Thesis	Discharge of sewage-polluted groundwater into Malibu Creek and Lagoon resulting from groundwater surface interactions

Recent Studies relating Septic Systems to Beach pathogens

Research completed over the last ten years has expanded the understanding of beach bacteria sources and mechanisms of transport. For example, it has been demonstrated that the fecal-indicator-bacteria enterococcus is present on all California beaches, a contamination that is related to both human and non-human sources (Yamahara, 2007) and can be associated with septic system effluent (Boehm et. al., 2004; De Sieyes et. al , 2008). Enterococcus can be transported, stored and, under some conditions, grown in the beach environment. Groundwater transport of bacteria occurs and has been related to nitrogen levels from on-site wastewater treatment systems.

In 2003, Mark Borchardt and others reported in Environmental Health Perspectives, Vol. 111, No. 5 that the density of septic systems correlated with increased rates of infectious diarrhea in children in central Wisconsin. Fecal enterococcus bacteria were one of the indicators used to denote the presence of human pathogens. Borchardt found that viral diarrhea increased by 8% for every additional holding tank in 640 acres and bacterial diarrhea increase by 22% for every additional holding tank in 40 acres. While household wells were sampled for bacterial, risks relate to surface contact with pathogens near septic systems.

In 2004, Alexandria Boehm and others reported in Environmental Science and Technology Vol. 38, No. 13 that groundwater discharge of microbial pollution moved from a shallow beach aquifer on to the beach face at Huntington Beach. While fecal-indicator-bacteria were found in only one groundwater sample, column studies show that the transport of enterococcus is not inhibited by sand collected in the field. In addition, radon isotopes characteristic of groundwater linked 38% of the enterococcus variation to groundwater discharge.

In 2007, Kevin Yamahara and others reported in Environmental Science and Technology, Vol. 41, No. 12, that 91% of sampled California coastal beaches had enterococcus. The presence of a source, such as a river, wave shelter and surrounding anthropogenic land use correlated with a significant portion of the population variation. An enterococcus gene study identified a human fecal source in a nearby storm drain.

In 2008, Nicholas De Sieyes and others reported in the Journal of Limnology and Oceanography Vol. 53, No. 4, that fresh nutrient-rich groundwater discharges in fortnightly pulsing into the ocean across a beach. While fecal indicator bacteria and human gene analysis found in monitoring wells were attributed to pollution from adjacent septic systems, the concentrations of these pathogens did not increase with nutrients.

In 2009, Kevin Yamahara and others reported in Applied and Environmental Microbiology, Vol. 75, No. 6, that enterococcus bacteria, related to human enteric disease from swimming in marine waters, can replicate in beach sand with repeated wetting.

In 2009, the American Association for the Advancement of Science summarized studies on Methicillin Resistant Staphylococcus Aureus bacteria (MSRB) found in ocean water and on beaches in Florida in 2009. The bacterial infections are resistant to anti-biotics and are more commonly found in hospitals, but are now known to be transmitted to the beach through contact with infected individuals and, according to one report, through municipal effluent. The ability of the bacteria to travel via sewage has not been quantified.

Other studies have been completed within the last twenty years to characterize pathogen sources and the mechanisms of transport since 1970 when concerns about a human health impact were first discussed for the Malibu Civic Center Area (Bloch, A.B. et. al., 1990; Boehm, A et.al., 2004; Borchardt, M.A. et. al., 2003; Chu A.K. and Sander, B.F., 2008; Cuyk. S.V. et. al. 2004., De Sieyes, N.R., Yamahara, K.M., Layton, B.A., Joyce, E.H., & Boehm, A.B. 2008; Goyal, S.M., & Gerba, C.P. August 1979; Ground Water Monitoring and Assessment Program. May 1999; Noble, R.T, & Fuhrman, J.A.,1996;Schaub, S.A., & Sorber, C.A. May 1977; Schijven, J.F. & Hassanizadeh, S.M. 2002; Stramer, S.L., & Cliver, D.O. 1984;Tiefenthaler, L.L, Stein, E.D., & Lyon, G.S. January 2008; United States Environmental Protection Agency. August 2002;Vaughn, J.M., Landry E.F., Baranosky, L.J., Beckwith, C.A., Dahl, M.C., & Delihas, N.C. July 1978;Yates, M.V., Gerba, C.P., & Kelley, L.M. April 1985;Yates, M.V., Yates, S.R., Warrick, A.W., & Gerba C.P. September 1986;Yamahara, K.M., Layton, B.A., Santoro, A.E., & Boehm, A.B. 2007;Yamahara, K.M., Walters, S.P., & Boehm, A.B. January 6, 2009).

These studies have shown that the beach is a more complex microbiological environment than was previously understood. Familiar fecal-indicator-bacteria like enterococcus have been found in animal and bird (Boehm et. al., 2004; De Sieyes et. al , 2008) feces. Enterococcus has been grown in the laboratory setting from unseeded ocean water samples (Yamahara, 2009) and found in a freshwater environment free from human impact (Tiefenthaler, 2008). Enterococcus has also been shown to persist for later discharge in the beach sand and occur in higher concentrations in organic beach debris (San Diego Regional Board-Newport Bay Total Maximum Daily Loads; Yamahara, 2007).

Anthropogenic enterococcus has been identified in marine water in sheltered urban beaches (Yamahara, 2007) and in nitrogen-rich water (De Sieyes, 2008; Boehm, 2004) attributed to septic discharge from septic systems through the groundwater into the Ocean. Radon rich water associated with groundwater discharge has been related to groundwater discharge of enterococcus on a beach in an urban setting (Boehm et. al., 2004; De Sieyes et. al , 2008).

Recent work also shows that the beach is a more complex hydrologic environment than the steady state condition than had been previously modeled (Stone 2005 Malibu Risk Assessment). Tidal and seasonal (neap and spring) freshwater transport rates have both been reported as higher (Boehm et. al., 2004; De Sieyes et. al , 2008) while ground transport rates during low tide are reported to be higher (Izbicki, 2009). Bacteria have been shown to move unimpeded through field sand samples (Yamahara, 2007). Other workers used sand column studies to show bacteria and virus retention and remobilization was related to the movement of organic material. Sand filtration studies for sewage treatment plants describe 'breakthrough' or bacterial transport for both small (viruses) and large particles (bacteria) in the dynamic condition of 'backwashing' or sand re-packing which takes place in a sand filter and on a beach.

Studies of groundwater do not report bacteria in concentrations consistent with the bacteria measurements taken on the adjacent beach (Boehm, 2004; De Sieyes, 2008). Hydrological mounding beneath the septic areas may affect water table gradients otherwise dependent on tides and freshwater subsurface movement and may result in unpredicted flow paths and either limit or enhance septic discharge (Izbicki, 2009). Similarly, bacteria and viruses have recently been shown to adhere and remain viable in organic material (Yamahara, 2007; Azadpour-Keeley, 2003; Noble, 1996; Schaub, 1997, Schijven, 2002; Stramer, 1984) until remobilized. Other mechanisms which may result in the preservation of enterococcus include elevated nitrogen and/or oxygen levels (Vaughn, 2008; Azadpour-Keeley, 2003; Yates, 1985, 1986) in the subsurface or on the beach face. Further, the subsurface septic plumes have been found to stay intact during subsurface movement (Groundwater Monitoring and Assessment Program: Baxter, Minnesota, 1999).

Possible Sources and Transport Mechanisms for Bacteria in the Malibu Civic Center.

Figure 15 shows the Malibu Civic Center with planned development (Questa, 2003), and the line of the cross section shown in Figure 16. The cross section shows possible paths of transport for the bacteria discharged into septic leachfields/seepage pits to Malibu Creek, Malibu Lagoon and the ocean. Note in the cross section that bacteria leaving septic systems in Malibu Colony or adjacent to Legacy Park have the shortest travel times and fewest opportunities for subsurface physical detention, chemical attack or biological predation.

The movement of bacteria from the Civic Center area north of Pacific Coast Highway via subsurface transport to Surfrider Beach under summer conditions would require preservation or growth of enterococcus and movement through the beach barrier with remobilization in marine water (see Figure 16 [cross section]). Human fecal enterococcus must survive physical, chemical and biological destruction in the subsurface before their discharge, enterococcus from higher elevations within the watershed must travel further and both light and distance are known to cause de-activation of both viruses and bacteria (Azadpour-Keeley, 2003;Yates, 1985, 1986).

Figure 16. Planned development in the Malibu Civic Center from Questa 2003 and cross section line

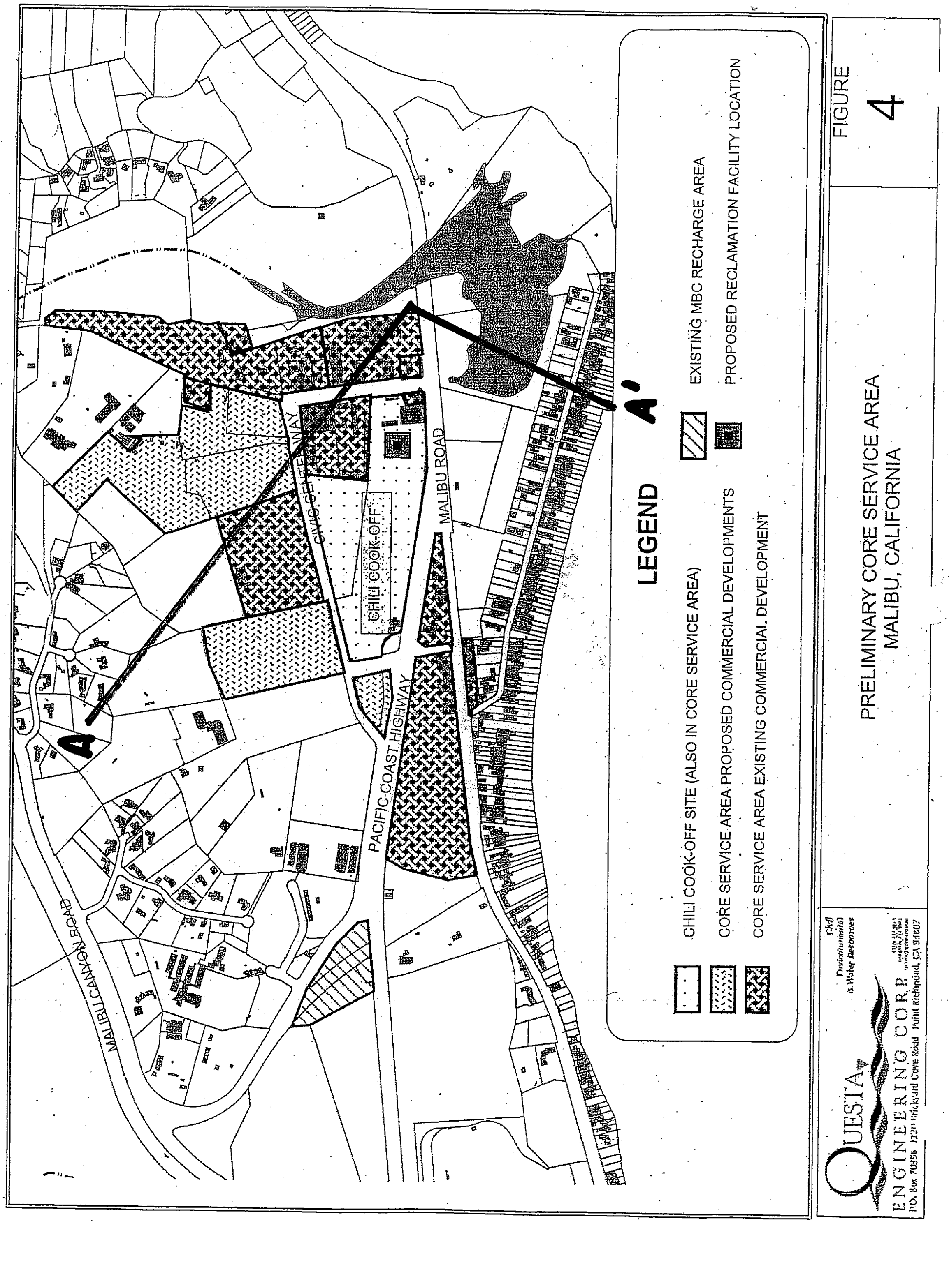
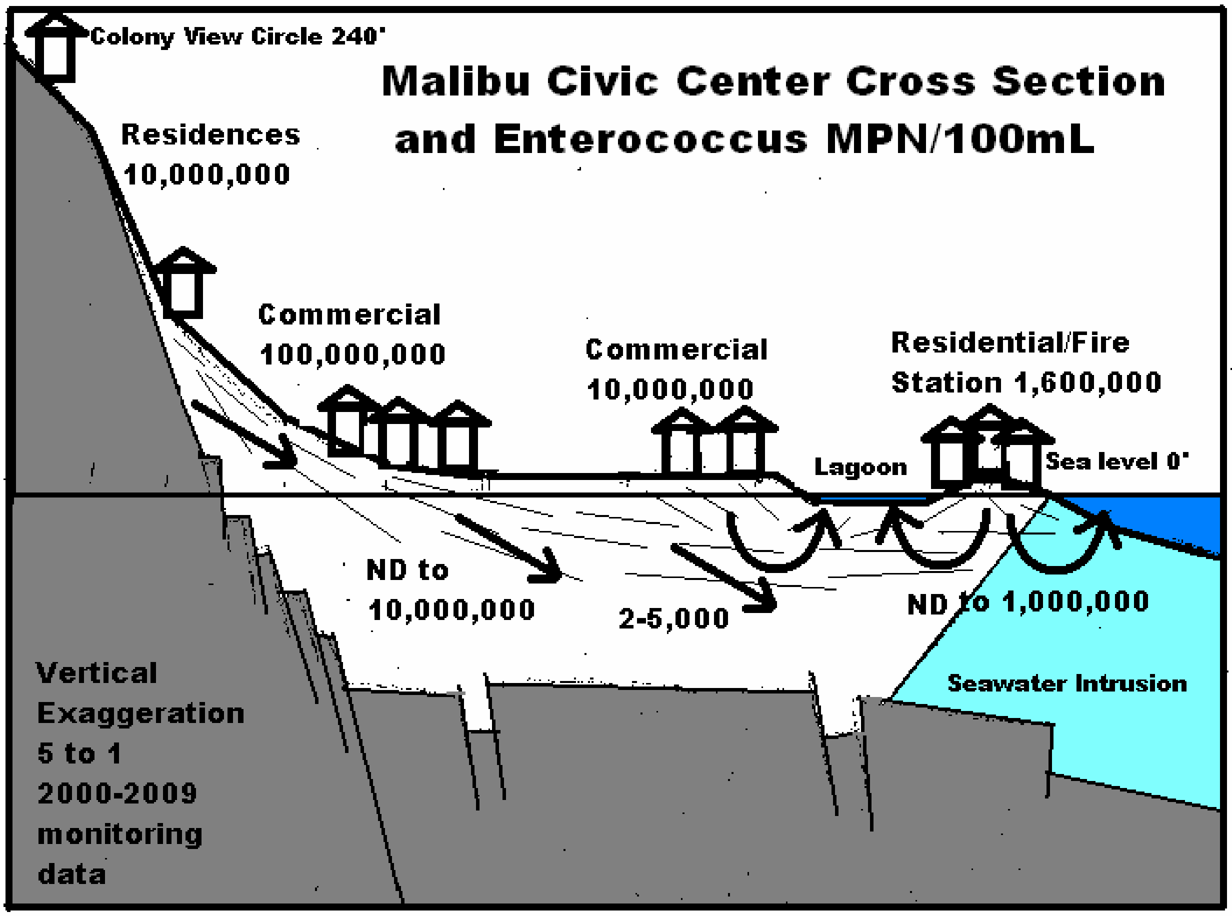


Figure 17. Cross Section A to A’ showing facility and groundwater bacteria and flow paths



5. Conclusion

Malibu Creek, Lagoon, and nearby beaches are popular not only within the local community but as a destination for visitors as well. In the Basin Plan, the Regional Board has designated these waters for both water contact recreation (e.g. swimming) and non-contact water recreation (e.g. sunbathing, aesthetic enjoyment), and set standards at levels that will protect human health.

As determined by the Regional Board and US Environmental Protection Agency, surface waters in the Malibu Creek Civic Center area are impaired for water contact recreation, and consistently have failed to meet standards set to protect ingestion of waters by swimmers and surfers. Repeated failures to meet standards set to protect public health has resulted in a ‘beach bummer’ reputation for Surfrider Beach.

To examine the hydraulic connection of discharges from OWDSs through groundwater to nearby surface waters, staff evaluated more than 8,000 samples of wastewater effluent, underlying or nearby groundwater, and surface waters. Staff determined that pathogens from wastewaters migrate to surface waters and that, consistent with data supporting the designations of impairments, the levels of pathogens do not meet standards protective of human health. Staff also determined that risks of infectious disease from water contact recreation were elevated at beaches in the Malibu Civic Center area versus comparable beaches with sewers.

Staff also reviewed numerous previous studies, and found conclusions from these other studies to be consistent with staff's determination of impairment to the beneficial use of water contact recreation.

<u>**ATTACHMENT 3-1: STATISTICS**</u>

Statistical Significance

The application of statistical tools to the beach bacteria data sets revealed that standard tests have a high potential to produce misleading results. Additional statistical tests were used to confirm a significant difference between enterococcus interval frequency distributions for septic and sewered beaches in 2005, 2006 and 2007 for non-MS-4 beaches not including beaches with direct discharge to beach wave wash.

The examination of enterococcus on beaches requires the manipulation of very large data sets. As an example, 7,081 measures were collected from beaches receiving MS-4 discharge in the summers of 2005 through 2008. The measures were not all normally distributed and were dominated by densities at or below 10 Most Probable Number (MPN)/100 mL (considered to be non-detect), with the presence of occasional measures above 24,000 MPN/100mL. The majority of the bacteria measures in the beach data sets had low and high enterococcus densities which together constitute a log normal distribution, but with interval frequencies between 50 and 1,000 MPN/100 mL which were not consistent with a log normal distribution.

Statistics which rely on normal distributions may produce false positive measures of significance for the beach bacteria populations. Many single beach samples assembled through weekly sampling over 4 summers did not have sufficiently large populations to allow statistical assessment with such tests. For example, an attempt to compare Surfrider and Manhattan (40^{th} Street) beaches during the summer of 2007 was not successful because of the distribution of the measures for Manhattan Beach (9 measures below 10 MPN/100 mL, one of 24,000 MPN/100mL and 5 of 10 MPN/100mL). The resulting sample distribution was not normally distributed nor was the natural log of the sample distribution normally distributed. A comparison of the data with the larger sample at Surfrider Beach varied with the interval to which the statistical test was applied.

Where data sets are large, normal distributions can be created through repeated sampling. However, the largest data sets also had very large measurements and many small measurements, suggesting that populations were not the result of sample bias. As an example, annual populations for all sewered and septic beaches which had high correlation coefficients for large and small intervals, but not for the interval between 50 and 1,000 MPN/100 mL.

If normality was assumed and Student's t-tests and Correlation Coefficient were applied, the results were repeatedly inconsistent. Some data sets which Student's t-test showed to have intervals from different populations were also found to have high Correlation Coefficients. Where a correlation was suspected and the data sets were plotted, the typical result was that a single very high or numerous very low values produced a large correlation coefficient (R^2) erroneously indicating that the correlation is good. Where the sample sets were distinct, did not correlate, and were suspected to be samples from different populations, the Student t-test (p) or the Student's t-test of the natural log (ln p) were measured. Small measures of p or ln p indicated that some populations were distinct with values above .05 considered significant (less than 1 chance in 20) .The typical result was that a Student t-test finding that the populations to be distinct was highly dependent on the size of the sample (and the number of values below 25 MPN/100mL) or the presence of a few measures above 1000 MPN/100 mL.

The statistic package Minitab was used to apply the Chi-square test. When the chi square correlation was made on truncated populations of all beaches with some values below 10 MPN/100 ML removed, the results ($p<.05$) indicated that septic and sewered beaches did not belong to the same population. However, the removal of about half of the population was of concern.

Non parametric statistical tools were applied to the same data sets. When all septic and sewered beaches for the year 2005 - 2008 were contrasted using the non-parametric Quartile Hypothesis Test, the Wilcoxon-Mann-Whitney (WMW)Test and Gehan Test from EPA's ProUCL statistical program, the Quartile Test results recommend using the WMW Test. However, the WMW Test is only applicable for data set with less than 40% non-detect level of 10 MPN/100mL. Therefore, the Gehan Test is the most appropriate Test for this study. The Gehan test looks at all intervals and emphasizes the mean/median interval. The results are summarized in Tables 1 through 4.

The Null Hypothesis is termed "Septic Beach Mean/Median Less Than or Equal to Sewer Beach Mean/Median;" and the Alternative Hypothesis is "Septic Beach Mean/Median Greater Than Sewer Beach Mean/Median" using Gehan Form 1 Test.

The result of the Gehan Test for 2005, 2006 and 2008 shows that the Null Hypothesis is rejected by a low P-value with an alpha value of 0.05 (a confidence level of 95%) , which rejects the Null Hypothesis and supports the Alternative Hypothesis "Septic Beach Mean/Median Greater Than Sewer Beach Mean/Median". The 2007 data is not consistent with the results of 2005, 2006, and 2008 due to low groundwater discharge to beaches after dry winter. The same results were also obtained with an alpha value of 0.01 (a confidence level of 99%) that enterococcus concentration at septic beaches is higher than concentration at sewered beaches statistically.

Table 1 - 2005 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options		
From File	WorkSheet.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)	
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median	

Area of Concern Data: septic
Background Data: sewered

Raw Statistics

	Site	Background
Number of Valid Data	358	754
Number of Non-Detect Data	113	482
Number of Detect Data	245	272
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	31.56%	63.93%
Minimum Detected	20	20
Maximum Detected	9208	4200
Mean of Detected Data	261.7	368.9
Median of Detected Data	87	99
SD of Detected Data	661.3	591.3

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test

Value	9.461
Critical z (0.95)	1.645
P-Value	1.52E-21

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

Table 2 - 2006 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options		
From File	WorkSheet.wst	
Full Precision	OFF	
Confidence Coefficient	95%	
Substantial Difference	0	
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)	
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median	

Area of Concern Data: septic
Background Data: sewered

Raw Statistics

	Site	Background
Number of Valid Data	685	1377
Number of Non-Detect Data	293	921
Number of Detect Data	392	456
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	42.77%	66.88%
Minimum Detected	20	20
Maximum Detected	24192	48010
Mean of Detected Data	324.9	532.3
Median of Detected Data	86.5	42
SD of Detected Data	1320	2701

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test

Value	11.74
Critical z (0.95)	1.645
P-Value	4.17E-32

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

DRAFT JULY 31 2009

Table 3 - 2007 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: septic
Background Data: sewered

Raw Statistics

	Site	Background
Number of Valid Data	731	1364
Number of Non-Detect Data	574	1023
Number of Detect Data	157	341
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	78.52%	75.00%
Minimum Detected	10	20
Maximum Detected	2000	24192
Mean of Detected Data	127.5	260
Median of Detected Data	52	41
SD of Detected Data	281	1713

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test	
Value	-1.226
Critical z (0.95)	1.645
P-Value	0.89

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site <= Background
P-Value >= alpha (0.05)

Table 4 - 2008 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Less Than or Equal to Background Mean/Median (Form 1)
Alternative Hypothesis	Site or AOC Mean/Median Greater Than Background Mean/Median

Area of Concern Data: septic
Background Data: sewered

Raw Statistics

	Site	Background
Number of Valid Data	734	1315
Number of Non-Detect Data	514	979
Number of Detect Data	220	336
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	70.03%	74.45%
Minimum Detected	20	20
Maximum Detected	2000	2000
Mean of Detected Data	146.8	90.55
Median of Detected Data	53	31
SD of Detected Data	290.3	226.3

Site vs Background Gehan Test

H0: Mean/Median of Site or AOC <= Mean/Median of background

Gehan z Test	
Value	3.45
Critical z (0.95)	1.645
P-Value	2.81E-04

Conclusion with Alpha = 0.05
Reject H0, Conclude Site > Background
P-Value < alpha (0.05)

An additional measurement of significance using the Gehan test can be achieved by adding an investigation value (i.e. enterococcus concentration) to the mean/median before assessing the Null hypothesis to demonstrate the magnitude of difference using Gehan Form 2 Test. The larger this value, called substantial difference, S, the greater the difference between the populations, i.e., the greater an S, the greater an enterococcus concentration for septic beaches versus sewered beaches. Definitions from EPA's ProUCl program are detailed follow.

> Δ (delta): The true difference between the mean concentration of X in one sample and the mean of X in a second sample. Delta is an unknown parameter which describes the true state of nature. Hypotheses about its value are evaluated using statistical hypothesis tests. In principle, we can select any specific value for Δ and then test if the observed difference is as large as Δ or not with a given confidence and power.

> S (substantial difference): A difference in mean concentrations that is sufficiently large to warrant additional interest based on health or ecological information. S is the investigation level. If Δ exceeds S, the difference in concentrations is judged to be sufficiently large to be of concern, for the purpose of the analysis. A hypothesis test uses measurements from the site and from background to determine if Δ exceeds S.

In the study cases, the S value was calculated to determine the significance of the contrast between sewered and septic beaches for the summers of 2005, 2006, 2007 and 2008. The resulting S values show that septic beaches were most distinct from sewered beaches in 2005 after wet winter and not distinct in 2007 after dry winter. A substantial difference exists between septic and sewered beaches for every year except 2007.

Year	2005	2006	2007	2008
S value MPN/100 mL	108	89	0	21

The Gehan calculation with S factor calculation for the 2005 - 2008 are shown in Tables 5 - 8.

Table 5 – 2005 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	108
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median plus a Substantial Difference, S (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median plus a Substantial Difference, S

Area of Concern Data: septic beaches
Background Data: sewered beaches

Raw Statistics

	Site	Background
Number of Valid Data	358	754
Number of Non-Detect Data	113	482
Number of Detect Data	245	272
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	31.56%	63.93%
Minimum Detected	20	20
Maximum Detected	9208	4200
Mean of Detected Data	261.7	368.9
Median of Detected Data	87	99
SD of Detected Data	661.3	591.3

Site vs Background Gehan Test

H0: Mu of Site or AOC >= Mu of background 108

Gehan z Test Value	-1.631
Critical z (0.95)	-1.645
P-Value	0.0514

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site >= Background + 108.00
P-Value >= alpha (0.05)

Table 6 – 2006 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	89
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median plus a Substantial Difference, S (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median plus a Substantial Difference, S

Area of Concern Data: septic beaches
Background Data: sewered beaches

Raw Statistics

	Site	Background
Number of Valid Data	685	1377
Number of Non-Detect Data	293	921
Number of Detect Data	392	456
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	42.77%	66.88%
Minimum Detected	20	20
Maximum Detected	24192	48010
Mean of Detected Data	324.9	532.3
Median of Detected Data	86.5	42
SD of Detected Data	1320	2701

Site vs Background Gehan Test

H0: Mu of Site or AOC >= Mu of background 89

Gehan z Test Value	-1.353
Critical z (0.95)	-1.645
P-Value	0.088

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site >= Background + 89.00
P-Value >= alpha (0.05)

Table 7 – 2007 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median plus a Substantial Difference, S (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median plus a Substantial Difference, S

Area of Concern Data: septic beaches
Background Data: sewered beaches

Raw Statistics

	Site	Background
Number of Valid Data	731	1364
Number of Non-Detect Data	574	1023
Number of Detect Data	157	341
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	78.52%	75.00%
Minimum Detected	10	20
Maximum Detected	2000	24192
Mean of Detected Data	127.5	260
Median of Detected Data	52	41
SD of Detected Data	281	1713

Site vs Background Gehan Test

H0: Mu of Site or AOC >= Mu of background 0

Gehan z Test Value	-1.226
Critical z (0.95)	-1.645
P-Value	0.11

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site >= Background + 0.00
P-Value >= alpha (0.05)

Table 8 – 2008 Gehan Site vs Background Comparison Hypothesis Test for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	21
Selected Null Hypothesis	Site or AOC Mean/Median Greater Than or Equal to Background Mean/Median plus a Substantial Difference, S (Form 2)
Alternative Hypothesis	Site or AOC Mean/Median Less Than Background Mean/Median plus a Substantial Difference, S

Area of Concern Data: septic beaches
Background Data: sewered beaches

Raw Statistics

	Site	Background
Number of Valid Data	734	1315
Number of Non-Detect Data	514	979
Number of Detect Data	220	336
Minimum Non-Detect	10	10
Maximum Non-Detect	10	10
Percent Non detects	70.03%	74.45%
Minimum Detected	20	20
Maximum Detected	2000	2000
Mean of Detected Data	146.8	90.55
Median of Detected Data	53	31
SD of Detected Data	290.3	226.3

Site vs Background Gehan Test

H0: Mu of Site or AOC >= Mu of background 21

Gehan z Test Value	-0.305
Critical z (0.95)	-1.645
P-Value	0.38

Conclusion with Alpha = 0.05
Do Not Reject H0, Conclude Site >= Background + 21.00
P-Value >= alpha (0.05)

ATTACHEMENT 3-2: REFERENCES

Ambrose, Richard. May 14, 2008. Ecological Goals. Malibu Legacy Park Project prepared by Richard F. Ambrose in association with RMC Water and Environment

Allen, L.A., Brooks, E., Williams, & I.L. November 1949. Effect of Treatment at the Sewage Works on the Numbers and Types of Bacteria in Sewage. Prepared for The Journal of Hygiene by L.A. Allen, E. Brooks, & I.L. Williams.

Azadpour-Keeley, A., Faulkner, B.R., & Chen, J.S. April 2003. Movement and Longevity of Viruses in the Subsurface. Prepared for United States Environment Protection Agency by A. Azadpour-Keeley, B.R. Faulkner, and J.S Chen

Bales, R.C., Gerba, C.P., Grondin, G.H., & Jensen, S.L. 1989. Bacteriophage Transport in Sandy Soil and Fractured Tuff. Prepared for Applied and Environmental Microbiology by R.C. Bales, C.P. Gerba, G.H. Grondin, & S.L. Jensen.

Bing Yen & Associates, Inc. January 5, 2001. Report of Malibu Civic Center Groundwater Evaluation. Prepared for City of Malibu by Bing Yen & Associates, Camarillo CA.

Bloch, A.B., Stramer, S.L., Smith, D., Margolis, H.S., Fields, H.A., McKinley, T.W. Gerba, C.P., Maynard, J.E., & Sikes, R.K. April 1990. Recovery of Hepatitis A Virus from Water Supply Responsible for a Common Source Outbreak of Hepatitis A. Prepared for American Journal of Public Health by A.B. Bloch, S.L. Stramer, D. Smith, H.S. Margolis, H.A. Fields, T.W. McKinley, C.P, Gerba, J.E. Maynard, & R.K. Sikes.

Boehm, A.B., Shellenbarger, G.G., & Paytan, A. 2004. Groundwater Discharge: Potential Association with Fecal Indicator Bacteria in the Surf Zone. Prepared for Environmental Science & Technology by A.B Boehm, G.G. Shellenbarger, & A. Paytan.

Borchardt, M.A., Bertz, P.D., Spencer, S.K.,& Battigelli, D.A. 2003. Incidence of Enteric Viruses in Groundwater from Household Wells in Wisconsin. Prepared for Applied and Environmental Microbiology by M.A. Borchardt, P.D. Bertz, S.K. Spencer, & D.A. Battigelli.

Borchardt, M.A., Chyou, P.H., DeVries, E.O., & Belongia, E.A. May 2003. Septic System Density and Infectious Diarrhea in a Defined Population of Children. Prepared for Environmental Health Perspectives by M.A, Borchardt, P.H. Chyou, E.O. DeVries,& E.A. Belongia.

Cabelli, V.J. August 1983. Health Effects Criteria for Marine Recreational Waters. Prepared for Health Effect Research Laboratory Office of Research and Development by V.J. Cabelli.

CDM. August 10, 2006. Technical Memorandum Task 10, TMDL Implementation Analysis.

CDM. February 27, 2007. Integrated Total Maximum Daily Load Implementation Plan for the Malibu Creek Watershed. Prepared for Los Angeles County Department of Public Works by CDM, Irvine CA.

Chu, A.K., & Sanders, B.F. August 2008. Data Requirements for Load Estimation in Well-Mixed Tidal Channels. Prepared for Journal of Environmental Engineering by A.K. Chu, & B.F Sanders.

City of Malibu. November 5, 2002. Ordinance No. 242. City Council of the City of Malibu.

City of Marco Island. City of Marco Island Position Paper Septic Tank Replacement Program. Prepared by the City of Malibu for the City of Malibu.

Crawford, Multari & Clark Associates. July 1997. Draft, City of Malibu, Civic Center Specific Plan. Prepared for City of Malibu by Crawford, Multari & Clark Associates, San Luis Obispo CA.

Cuyk, S.V., Siergrist, R.L., Lowe, K., & Harvey, R.W. 2004. Vadose Zone Processes and Chemical Transport. Prepared for Journal of Environmental Quality by S.V Cuyk, R.L. Siergrist, K. Lowe, & R.W. Harvey.

De Sieyes, N.R., Yamahara, K.M., Layton, B.A., Joyce, E.H., & Boehm, A.B. 2008. Submarine Discharge of Nutrient-Enriched Fresh Groundwater at Stinson Beach, California is enhanced during Neap Tides. Prepared for Limnol Oceanography by N.R. de Sieyes, K.M. Yamahara, B.A. Layton, E.H. Joyce, & A.B. Boehm.

Ensitu Engineering Inc. June 30, 2008. Advanced On-site Wastewater Treatment System Design, California Department of Health Services Engineering Report. Prepared for Malibu Lumber by Ensitu Engineering Inc, Morro Bay CA.

Ensitu Engineering Inc. August 13, 2008. Malibu Lumber Wastewater Flow Calculations Commercial Development without Restaurant Use. Letter addressed to Brett Thornton, prepared by Ensitu Engineering, Morro Bay CA.

Ensitu Engineering Inc. 2008. Advanced On-site Wastewater Treatment System Design, City of Malibu Engineering Report. Prepared for Malibu Lumber by Ensitu Engineering Inc., Morro Bay CA.

Gold, M.A. 1994. What are the health risks of swimming in the Santa Monica Bay?: An examination of the issues surrounding the public health debate. Prepared for University of California, Los Angeles by M.A. Gold.

Goyal, S.M., & Gerba, C.P. August 1979. Comparative Adsorption of Human Enteroviruses, Simian Rotavirus, and Select Bacteriophages to Soils. Prepared for Applied and Environmental Microbiology by S.M. Goyal, & C.P. Gerba.

Gronewold, A.D.,& Wolpert, R.L. April 7, 2008. Modeling the Relationship between Most Probable Number (MPN) and Colony – Forming Unit (CFU) Estimates of Fecal Coliform Concentration. Elsevier.

Ground Water Monitoring and Assessment Program. May 1999. Effect of Septic Systems on Ground Water Quality – Baxter, Minnesota. Prepared for Ground Water Monitoring and Assessment Program by Ground Water Monitoring and Assessment Program

James, Kirsten. November 19, 2008. Comments on Tentative Waste Discharge Requirements, Water Reclamation Requirements and Monitoring and Reporting Program for Malibu Lumber. Heal The Bay, Santa Monica CA.

Jones & Stokes. 2008. Malibu Legacy Park Project, Draft Environmental Impact Report. Prepared for City of Malibu by Jones & Stokes, Los Angeles CA.

REGIONAL BOARD. 1972. Resolution No. 72-4, Policy Statement Relative to Sewage Disposal in the Malibu Area. California Regional Water Quality Control Board, Los Angeles Region.

LARWCB. December 14, 1998. Resolution No. 98-023 Malibu Creek Watershed. California Regional Water Quality Control Board, Los Angeles Region.

REGIONAL BOARD. 1990. Regional Water Quality Control Board's Interim Policy on the Use of Septic Tanks. California Regional Water Quality Control Board, Los Angeles Region.

REGIONAL BOARD. 2002. Santa Monica Bay Beaches Wet Weather Bacteria TMDL, Item #5 Regional Board Workshop, June 27, 2002. California Regional Water Quality Control Board, Los Angeles Region.

REGIONAL BOARD. 2004b. Total Maximum Daily Loads for Bacteria, Malibu Creek Watershed. California Regional Water Quality Control Board, Los Angeles Region.

REGIONAL BOARD. 2008. 520th Regular Board Meeting, Item 16, Consideration of Termination of Memorandum of Understanding for On-site Wastewater Treatment Systems for the City of Malibu. California Water Quality Control Board, Los Angeles Region.

REGIONAL BOARD. 2008b. 521st Regular Board Meeting, Item 18, Revised Order, Waste Discharge Requirements/Water Reclamation Requirements and Monitoring and Reporting Program for City of Malibu's Malibu Lumber at City of Santa Monica's Legacy Park. California Regional Water Quality Control Board, Los Angeles Region.

Lucero, Gene. 2008. Submittal of Comments to Tentative Waste Discharge Requirements and Water Reclamation Requirements for Malibu Lumber LLC. Latham & Watkins, LLP.

National Center for Environment Research. 2003. Final Report: Fate for Pathogens in Storm Water Runoff. Prepared for National Center for Environment Research by National Center for Environment Research.

Nicosia, L.A., Rose, J.B., Stark, L., & Stewart, M.T. 2001. Ground Water Quality. Prepared for Journal of Environment Quality by L.A Nicosia, J.B Rose, L. Stark, and M.T. Stewart.

Noble, R.T, & Fuhrman, J.A. October 25, 1996. Virus Decay and Its Causes in Coastal Waters. Prepared for Applied and Environmental Microbiology by R.T. Noble, & J.A. Fuhrman.

Office of Water. October 2006. Occurrence and Monitoring Document for the Final Ground Water Rule. Prepared for Office of Water by the Office of Water.

Peter Warshall & Associates and Philip Williams & Associates. 1992. Malibu Wastewater Management Study, A Human Ecology of the New City. Prepared for City of Malibu by Philip Williams and Associates, San Francisco CA and Peter Warshall & Associates, Tucson AZ.

Pradhan, S., Hoover, M.T., Clark, G.H., Gumpertz, M., Wollum, A.G., Cobb, C., & Strock, J. February 2008. Septic Tank Additive Impacts on Microbial Populations. Prepared for Journal of Environmental Health by S. Pradhan, M.T. Hoover, G.H. Clark, M. Gumpertz, A.G. Wollum, C. Cobb, & J. Strock

Questa Engineering Corporation. July 7, 2003. Preliminary Conceptual Plan for Wastewater Reclamation in the Civic Center Area, Malibu, California. Prepared for City of Malibu by Questa Engineering, Santa Barbara CA.

RMC Water and Environment. August 15, 2008. Irrigation of Legacy Park with Treated Effluent from Lumber Yard Development. Technical Memorandum prepared by RMC Water and Environment.

RMC Water and Environment. May 14, 2008. Summary of Stormwater Management and Water Quality Improvements for Lower Malibu Creek and Lagoon. Prepared by RMC Water and Environment for City of Malibu, Legacy Park.

Rong, Y. November 3, 1997. Pitfalls in Statistics for Environmental Sampling Evaluation. Prepared for Environmental Geosciences by Yue Rong.

Santa Monica Bay Restoration Project. 1999. Malibu Creek Watershed Restoration Activities Draft. Malibu Creek Watershed Executive Advisory Council.

Santa Monica Bay Restoration Project. January 2001. Improving Septic System Management in the Santa Monica Bay Watershed. Santa Monica Bay Restoration Project, Septic System Task Force.

Schaub, S.A., & Sorber, C.A. May 1977. Virus and Bacteria Removal from Wastewater by Rapid Infiltration Through Soil. Prepared for Applied and Environmental Microbiology by S.A. Schaub, & C.A. Sorber.

Schijven, J.F. & Hassanizadeh, S.M. 2002. Virus Removal by Soil Passage at Field Scale and Groundwater Protection of Sandy Aquifers. Prepared for Water Science and Technology by J.F Schijven & S.M Hassanizadeh .

Stone Environmental, Inc. 2004. Final Report- Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu CA. Prepared for Santa Monica Bay Restoration Commission by Stone Environmental, Montpelier VT.

Stone Environmental, Inc. April 9, 2004. IWIMS Design Document, City of Malibu Clean Beaches Initiative. Prepared for S. Groner Associates, Inc by Stone Environmental, Montpelier VT.

Stone Environmental, Inc. May 6, 2004. IWIMS Design Document, City of Malibu Clean Beaches Initiative. Prepared for S. Groner Associates, Inc by Stone Environmental, Montpelier VT.

Stramer, S.L., & Cliver, D.O. 1984. Septage Treatments to Reduce the Numbers of Bacteria and Polioviruses. Prepared for Applied and Environmental Microbiology by S.L. Stramer,& D.O. Cliver.

Tiefenthaler, L.L, Stein, E.D., & Lyon, G.S. January 2008. Fecal Indicator Bacteria Levels During Dry Weather form Southern California Reference Streams. Prepared for Southern California Coastal Water Research Project by L.L. Tiefenthaler, E.D. Stein, & G.S. Lyon.

Tim, Heather. November 1994. Review of Monitoring and Response Protocol for the Malibu Creek Watershed. Santa Monica Bay Restoration Project.

Thorsen, Jim. 2008. Letter in Response to the Los Angeles Regional Water Quality Control Board's Letter Regarding Notification of Incomplete Application for Waste Discharge Requirements for Malibu Lumber. City of Malibu, CA.

United States Environmental Protection Agency. January 2001. Linkage between Water Quality Targets and Pollutant Sources. Prepared for United States Environmental Protection Agency by United States Protection Agency.

United States Environmental Protection Agency. August 2002. Predicting Attenuation of Viruses During Percolation in Soils. Prepared for United States Environmental Protection Agency by United States Protection Agency.

University of California, Los Angeles. May 200. Lower Malibu Creek and Lagoon Resource Enhancement and Management. Final Report to the California State Coastal Conservancy by UCLA.

URS Greiner Woodward Clyde. 1999. Final Report, Study of Potential Water Quality Impacts on Malibu Creek and Lagoon from On-site Septic Systems. Prepared for City of Malibu by URS Greiner Woodward Clyde, Santa Ana CA.

US Environmental Protection Agency. January 10, 2003. Total Maximum Daily Loads for Nutrient, Malibu Creek Watershed, Public Review Draft. US Environmental Protection Agency, Region 9.

Van Beveren & Butelo Inc. 2008. Supporting Geology/Soils Report Proposed Legacy Park Discharge Area. Prepared for Malibu Lumber, LLC by Van Beveren & Butelo Inc

Van Beveren & Butelo Inc. February 20, 2008. Supporting Geology/Soils Report Proposed Legacy Park Discharge Area. Prepared by Van Beveren & Butelo Inc for Malibu Lumber LLC.

Van Beveren & Butelo Inc. June 27, 2008. Response to Comments by the City of Malibu Proposed Legacy Park Discharge Area. Prepared by Van Beveren & Butelo Inc for Malibu Lumber LLC.

Van Beveren & Butelo Inc. August 11, 2008. Response to Comments by the City of Malibu Proposed Legacy Park Discharge Area. Prepared by Van Beveren & Butelo Inc for Malibu Lumber LLC.

Van Beveren & Butelo Inc. October 13, 2008. Response to Comments by the City of Malibu Proposed Legacy Park Discharge Area. Prepared by Van Beveren & Butelo Inc for Malibu Lumber LLC.

Vaughn, J.M., Landry E.F., Baranosky, L.J., Beckwith, C.A., Dahl, M.C., & Delihas, N.C. July 1978. Survey of Human Virus Occurrence in Wastewater-Recharged Groundwater on Long Island. Prepared for Applied and Environmental Microbiology by J.M. Vaughn, E.F. Landry, L.J. Baranosky, C.A. Beckwith, M.C. Dahl, & N.C. Delihas.

Viergutz, Richard, 2006, Discharge of Sewage-Polluted Groundwater into Malibu Creek and Lagoon Resulting from Groundwater Surface Interactions: MS Thesis, California State University, Los Angeles

Yates, M.V., Gerba, C.P., & Kelley, L.M. April 1985. Virus Persistence in Groundwater. Prepared for Applied and Environmental Microbiology by M.V. Yates, C.P. Gerba, & L.M. Kelley.

Yates, M.V., Yates, S.R., Warrick, A.W., & Gerba C.P. September 1986. Use of Geostatistics to Predict Virus Decay Rates for Determination of Septic Tank Setback Distances. Prepared for Applied and Environmental Microbiology by M.V. Yates, S.R. Yates, A.W. Warrick, and C.P. Gerba.

Yamahara, K.M., Layton, B.A., Santoro, A.E., & Boehm, A.B. 2007. Beach Sands along the California Coast are Diffuse Sources of Fecal Bacteria to Coastal Waters. Prepared for Environmental Sciences & Technology by K.M. Yamahara, B.A. Layton, A.E Santoro, & A.B. Boehm.

Yamahara, K.M., Walters, S.P., & Boehm, A.B. January 6, 2009. Growth of Enterococci in Unaltered, Unseeded Beach Sands Subjected to Tidal Wetting. Prepared for Applied and Environmental Microbiology by K.M. Yamahara, S.P Walters, & A.B. Boehm.

This page intentionally left blank.

State of California
California Regional Water Quality Control Board, Los Angeles Region

D R A F T

Draft Technical Staff Report

Evidence in support of an Amendment to the *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*

to Prohibit On-site Wastewater Disposal Systems in the Malibu Civic Center Area

A U G

Technical Memorandum #4:
Nitrogen Loads from Wastewater Flowing to Malibu Lagoon are a Significant Source of Impairment to Aquatic Life

5

by
Toni Callaway,* P.G., Engineering Geologist
Orlando Gonzalez, Water Resources Control Engineer
Groundwater Permitting Unit
and
C.P. Lai, Ph.D., P.E., Water Resources Control Engineer
TMDL Unit

2 0 0 9

** The authors would like to thank Regional Board staff, Joe Luera and intern Gina Ho for their assistance in preparing map and tables.*

Technical Memorandum #4:
Nitrogen Loads from Wastewater Flowing to Malibu Lagoon are a Significant Source of Impairment to Aquatic Life

by
Toni Callaway, P.G., Engineering Geologist
Orlando Gonzalez, Water Resources Control Engineer
Groundwater Permitting Unit
and
C.P. Lai, Ph.D., P.E., Water Resources Control Engineer
TMDL Unit

1. Purpose

Aquatic life in Malibu Lagoon is impaired by eutrophication resulting from excessive nitrogen loads. One of the sources of nitrogen loading is from discharges of wastewaters through on-site wastewater disposal systems (OWDSs) in the Malibu Civic Center area.

The purpose of this evaluation was to quantify cumulative nitrogen loads from OWDSs to Malibu Lagoon and compare the result with targets established through the TMDL for restoration of Malibu Lagoon.

2. Method

a. Malibu Civic Center Area Description and Data Collection

The City of Malibu does not provide regional sewage collection or treatment. Most wastewater generated in Malibu is treated by on-site wastewater disposal systems (OWDS) is the terminology used to describe wastewater discharged from both septic and advanced treatment systems. The Malibu Civic Center area for this evaluation corresponds to the lower two miles of the Malibu Creek watershed, which discharges to the Malibu Lagoon and the ocean, and was divided into 5 sectors as shown in Map 1. The Malibu Civic Center area includes the Malibu Valley, Winter Canyon, and the surrounding hills and the beaches located immediately north and south of the Lagoon.

The main commercial area in the Malibu Valley has historically been referred to as the Malibu Civic Center area. Both Los Angeles County and the City of Malibu have administrative offices there. Commercial development is concentrated along Pacific Coast Highway, Malibu Road, and Cross Creek Road adjacent to Malibu Creek just above the Malibu Lagoon.

Malibu Civic Center area has high groundwater and is also subject to flooding and tidal fluctuations. Shallow groundwater located in the Cross Creek area closest to Malibu Lagoon rises and drops in response to daily tides (Figure 1) and provides direct evidence of communication with Malibu Lagoon and the ocean.

Each Waste Discharge Requirements (WDR) includes a monitoring and reporting program that requires quarterly submission of self-monitoring data. These data include mass loading from wastewater discharged at commercial properties located in the Malibu Civic Center area. The subsequent evaluation of such data incorporates information from monitoring reports submitted to the Regional Board from the 4^{th} quarter 2004 to the 2^{nd} quarter 2009. The time interval for data inclusion is post release of the Stone Environmental, Inc. "Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu, California", in 2004 (2004 Stone Report).

This evaluation of nitrogen loading from the subsurface discharge of sewage incorporates information from Regional Board records. WDRs have been issued to most of the larger commercial dischargers in the area; and for these sites, a Monitoring and Reporting Program (MRP) is issued with every permit. For smaller businesses and private residents, we have used inventory listed in 2004 Stone Report.

Staff identified all of the commercial and residential properties located in the Malibu Civic Center area. The inventory consists of 349 residential properties and 38 commercial properties. When it was available, real data on wastewater volumes and total nitrogen (TN) concentrations from self-monitoring reports were used for this evaluation. When actual data were not available, conservation assumptions, based on information from published literature, were used to calculate nitrogen mass loading from all wastewater discharged in the Malibu Civic Center area. Results from the summation of the wastewater TN load are used to model attenuation of the nitrogen load as it moves from the point of discharge to groundwater and from groundwater as it flows to the Lagoon.

<u>Commercial Sites</u> - Several sources were used for the inventory of commercial properties located in the Malibu Civic Center area. The Regional Board's databases for permitted and un-permitted commercial facilities were the primary sources of information (Table 1). Other sources of information were the 2004 Stone Report, the City of Malibu, and the (2002) Malibu Survey by S. Groner & Associates. Wastewater discharge volumes from commercial properties located in the Malibu Civic Center area were extracted from the self- monitoring reports submitted for those facilities which are permitted. For the un-permitted commercial properties, additional information regarding business activities, population served, and the OWTS was utilized to estimate discharge volumes and wastewater strength.

<u>Residential Sites</u> – An inventory of residential properties located in the Malibu Civic Center area was listed in the 2004 Stone Report and used for its assessment of nitrogen loads contributed by residential properties in the Malibu Civic Center area[1]. This inventory was originally extracted from the City of Malibu Assessor's data of 2002. Information is posted in the Assessor's web-page by Assessor Identification Number (AIN). The number of bedrooms

[1] Stone Environmental, Inc., "Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu, California," 2004.

and bathrooms at each residence was used to estimate the wastewater discharge volume for each home. Calculations for the total nitrogen load discharged at residential property in the Malibu Civic Center area used the estimated wastewater discharge volumes. The residential property inventory sorted by sector location is listed in Table 2.

<u>Geographic Sectors</u> – Earlier evaluations approached the assessment of nitrogen loading by estimating the percentage of the groundwater flow from the entire lower Malibu Creek watershed, which discharges to the Lagoon versus the Pacific Ocean. Staff evaluation of nitrogen loading to the Lagoon used a different approach. All sectors of the entire watershed do not have an equal flow contribution to impairment of the Lagoon. Therefore, we divided the Malibu Civic Center area into geographic sectors to evaluate groundwater flow and nitrogen load contribution to evaluate impairment of the Lagoon from OWDS discharges. Initially, the area surrounding Malibu Lagoon was divided into five geographic sectors on the basis of surface topography (Map 1). Surface geographic features marking boundaries for the sectors are the gently sloping Valley floor, Malibu Creek, Pacific Coast Highway (PCH), and the Pacific Ocean. After considering flow gradients, subsurface hydrologic, and geologic conditions, two of the sectors were further divided on the basis of estimated flow contribution to the Lagoon. Each sector has a unique flow contribution to the Lagoon.

b. Total Nitrogen Loading from On-site Wastewater Treatment Systems

Slightly different approaches had to be taken to calculate total nitrogen loads from wastewater discharged at commercial and residential sites. Because the Regional Board issues permits or WDRs for wastewater discharges from commercial sites, there has been much more information on file for commercial properties. Historically, permitting of residential wastewater discharges has been delegated to local agencies.

i. Commercial Wastewater

We calculated the nitrogen loading from the commercial facilities dividing the commercial facilities into three groups. One group includes permitted facilities with advanced wastewater treatment, effluent volume limits, and discharge volume limits. At these permitted facilities, a Discharger is required to measure wastewater volumes, total nitrogen concentrations at "end of pipe," and submit this information to the Regional Board per the MRP issued with the WDR. Staff was able to use actual data from these sites to calculate the nitrogen loads. The second group includes smaller permitted commercial facilities where monitoring of wastewater discharge volume is required, but not effluent monitoring, because these facilities discharge domestic-type wastewater. In these cases, staff estimated nitrogen loading by using the provided flow information and published information on total nitrogen concentrations for domestic wastewater from similar types of businesses. The third group includes all un-permitted commercial facilities. In these cases, staff conducted drive-by inspections and collected information from several other sources regarding the OWTS, the business activity, and the population served in order to estimate wastewater flow, nitrogen concentration, and nitrogen loading from these commercial sites. A list of commercial facility is provided (See Table 1).

General Characterization of Wastewater Strength

<u>Biological Oxygen Demand (BOD)</u> - The 5-day BOD (BOD_5, 5-day, 20^{o}C) value is considered the best single strength measure of wastewater and/or polluted surface water containing degradable wastes. Thereafter, in this technical memorandum the term BOD refers to BOD_5, 5-day, 20^{o}C. BOD includes both carbonaceous and nitrogenous loading. The strength of wastewater is commonly expressed in terms of BOD, suspended solids, and chemical oxygen demand (COD). COD is commonly used to measure the amount of oxygen consumed under specific conditions in the oxidation of organic and inorganic material in both sewage and industrial waste. Both BOD and COD greatly impact the amount of dissolved oxygen in receiving water and determine the waste assimilative capacity of that surface water, an example being the Malibu Lagoon.

There are several chemical, physical, and biological parameters which provide information on water quality and organic pollution. These parameters are total and fecal coliform density, pH, nitrite, nitrate, Kjeldahl nitrogen which includes, ammonia nitrogen, and organic nitrogen, phosphates, chlorides, turbidity, suspended solids, temperature, grease fats and oils. BOD is commonly used for the characterization of domestic wastewater and the sizing and design of wastewater treatment systems. In this study, BOD is used to estimate total nitrogen when total nitrogen data is unavailable.

<u>Total Nitrogen Concentration Milligrams per Liter (mg/L)</u> **-** Total nitrogen concentration in milligrams per liter (mg/L) measured at “end of pipe” (e.o.p.) was used for load calculations when this information was available. Staff also used previous analyses of samples taken directly from the septic tanks. There is considerable information in Regional Board files on the septic tank composition for commercial sites in the Malibu Civic Center area.

Where neither e.o.p nor septic tank effluent analyses was available, staff based the estimation of total nitrogen on typical total nitrogen (TN) concentrations seen in the published literature on domestic wastewater composition. BOD values for commercial wastewater are more widely available than total nitrogen values and total nitrogen can be estimated as a proportion of BOD. Most wastewater engineering textbooks have tables showing the concentration of various elements in typical untreated domestic wastewater. Review of this information yields a percentage proportion or TN/BOD ratio[2] of 21% between total nitrogen (TN) and BOD. Another widely used textbook on wastewater engineering shows TN/BOD ratios ranging from 18% to 21%.[3] An average TN/BOD ratio of 20% was used to estimate the total nitrogen load at selected commercial sites.

In the nitrogen load spreadsheet, either a total nitrogen value from “end of pipe” or an estimated total nitrogen value derived from the TN/BOD ratio in the above tables was used for the nitrogen load spreadsheet, where no “end of pipe” total nitrogen value was available.

[2] Table 4-14, on page 181 in Crites and Tchobanoglous, “Small and Decentralized Wastewater Management Systems,” 1998.
[3] Table 3-16, page 109, Metcalf & Eddy, Inc. “Wastewater Engineering Treatment, Disposal and Reuse,” 3rd Edition, 1991.

Assumptions Made for Commercial Nitrogen Loading Calculations

Most of the larger commercial wastewater discharges have been permitted. There are 38 commercial sites located in the Malibu Civic Center area, 25 of which have been permitted. Total nitrogen concentrations measured at "end of pipe" and wastewater discharges volumes are available and were used for nitrogen loading calculations for these sites. When wastewater effluent analysis was not available, estimation of the total nitrogen load (TN) was based on published information for similar businesses or typical nitrogen concentrations for domestic wastewater. The total nitrogen load spreadsheet developed as Table 2 has two key assumptions: 1) BOD value based on the type of business, and 2) a total nitrogen load based on the average TN/BOD ratio found in the above popular wastewater textbooks. The volume of wastewater discharged is known for most commercial properties in the Malibu Civic Center area, but an estimate of wastewater volume had to be made for 10 of the smaller unpermitted commercial sites. Basic assumptions are listed below:

<u>TN/BOD Ratio</u> - Most of the larger commercial discharges in the Malibu Civic Center area, such as Malibu Colony Plaza, Malibu Creek Plaza, and the three Malibu Country Mart shopping centers, were permitted by the Regional Water Quality Control Board, and as a result we have analysis of septic tank samples, or "end of pipe" effluent where advanced OWTS have been installed. For shopping centers with a high proportion of restaurants and stand alone restaurants, we chose a very high BOD of 800 mg/L and a TN of 160 mg/L, but the septic tanks at the Malibu Country Mart shopping centers have to be pumped each week, and frequent pumping reduces both septic tank solids and the BOD and TN values, so ½ of the TN value was used.

For commercial dischargers such as small offices where we have no data, we choose a low BOD of 220 mg/L, and estimated the TN to be 40 mg/L.

For wastewater generated commercial facilities, such as schools, mid-range to high-range effluent strength and nitrogen concentrations were assumed. Depending on soil profile and groundwater separation, estimated total nitrogen was reduced to values ranging from 75 mg/L to 45 mg/L for these sites.

<u>Flow Rate</u> - For the purpose of calculating nutrient load due to wastewater discharges from OWDS, we have used actual flow data from monitoring reports for commercial facilities permitted by the Regional Water Quality Control Board. As stated previously, the septic discharge volume or flows for residential and smaller un-permitted commercial properties were estimated. For the residential properties, the flow estimate was based on the number of bathrooms.

Some of the smaller commercial properties remain unpermitted because the City of Malibu agreed to assume responsibility for any non-food preparation commercial properties discharging less than 2,000 gpd. For most of the smaller unpermitted commercial properties under the jurisdiction of the City of Malibu, Regional Board staff assumed a flow of 400 gpd. Many of the smaller commercial properties were not included in previous Malibu inventories and surveys.

2001 Tetra Tech[4] and 2003 U.S. Environmental Protection Agency [5] studies on Total Mass Daily Loads generated in the Malibu Civic Center area used total commercial wastewater flow of 75,000 gallons per day (gpd). Since 2001, the inventory on commercial properties located in the City of Malibu has increased. Current total wastewater volume generated by the commercial properties located in the Malibu Civic Center area is 128,469 gpd. This reflects a greater than 100% increase in the wastewater discharge volume estimated for commercial properties in the Malibu Civic Center area made by in earlier nitrogen loading studies, e.g. 2004 Stone Report, 2005 Questa Report, and 2001 Tetra Tech Report.

The Regional Board staff estimate of the wastewater discharge volume associated with residential OWDS located in the Malibu Civic Center area is 126,300 gpd. This volume was, virtually identical to the residential volume in the 2004 Stone Report. Our estimation of the commercial wastewater discharge volume is greater than commercial discharge volume estimate of 62,166 gpd in the 2004 Stone Report. This Regional Board staff assessment of total nitrogen load does not include non-septic or OWDS nitrogen load contributions.[6]

Formula Used for Calculation of Commercial Nitrogen Loading

Calculations of nitrogen loading from commercial properties were made with the equation shown below.[7]

<u>Equation (4-4):</u>

Mass Load, lb/d = (concentration, mg/L)(flow rate Mgal/d) [(8.345* lb/Mgal x mg/L)]

The above formula has two variables, including: 1) concentration of total nitrogen (TN) in milligrams per liter (mg/L), and 2) flow rate in million gallons per day (Mgal/d). (8.345* is a unit conversion factor)

For the permitted commercial properties, staff used reported average wastewater discharge volumes and total nitrogen values compiled from quarterly monitoring reports for the loading calculations. This evaluation includes more "end of pipe" nitrogen concentrations for our total nitrogen load calculations. Using reported or estimated using wastewater discharge volumes and total nitrogen concentrations, wastewater flow was multiplied by the nitrogen concentration to obtain the nitrogen loading rate.

[4] Tetra Tech, Inc., 2001, "Nutrient and Coliform Modeling for the Malibu Creek Watershed TMDL Studies", prepared for U.S. Environmental Protection Agency, Region 9 and the Los Angels Regional Water Quality Control Board, dated May 22, 2001.
[5] U.S. Environmental Protection Agency, 2003, "Total Maximum Daily Loads for Nutrients Malibu Creek Watershed", 2003.
[6] HRL industrial wastewater nitrogen load of .31 lbs/d; TN load from use of treated wastewater for landscape irrigation on Pepperdine University Campus; TN load carried by Malibu Creek from upper watershed; and the TN load from the Malibu Colony private golf course.
[7] Page 196, Crites and Tchobanoglous, "Small and Decentralized Wastewater Management Systems," 1998.

For unpermitted commercial facilities, flow and nitrogen concentration in the wastewater discharge for each business was estimated based on the information searched about the business activities and number of people working or type of business.

ii. Residential Wastewater

A different approach was needed to determine nitrogen mass loading from residential areas. Both discharge volume and nitrogen concentration of the residential domestic wastewater had to be estimated. Wastewater flow was based on the total number of houses and the bedrooms and bathrooms in each house. Residential property located in the Malibu Civic Center area was listed by Assessor Identification Number (AIN) from 2004 Stone Report. With AIN numbers, staff found the address and the number of rooms and baths for each residence posted on the County Assessor's web-page.

Staff assigned houses per their address into the five sectors. Addresses were viewed with aerial photo location guides to insure their section location. Once houses were grouped by sector, the total flow from each sector was calculated by multiplying the total number of homes by 100 gpd produced per bathroom. The next step was to estimate the nitrogen concentration in the domestic wastewater. Staff consulted published literature on wastewater to estimate the nitrogen load. The research indicated that typical untreated domestic wastewater has a range of total nitrogen concentrations. Review of standard engineering literature found nitrogen concentrations of 20 mg/L, 40 mg/L and 85 mg/L, defining domestic wastewater strength[1] as weak, medium or strong. Staff chose a nitrogen concentration of 45 mg/L for calculating the nitrogen load from residential sites. The residential property inventory was sorted by sector location is listed in Table 2.

Assumptions for Residential Flow and Total Nitrogen Concentration

Assumptions made to determine the flow and nitrogen loading from each residence in the absence of wastewater meter and sampling and analytic data of each discharge are listed below.

<u>100 Gallons per Day per Bathroom</u> - Regional Board staff estimated the flow by making the assumption that at least there is one user per bathroom (personal private bathroom) at home with a total water use per person of 100 gallons per day. The 100 gallons per person is widely used number for design and estimation purpose of wastewater flow[8].

<u>45 mg/L for Domestic Wastewater</u> - The nitrogen level in the domestic wastewater depends on the wastewater strength or organic load type discharged to OWDS. Waste strength is determined by considering food preparation practices, type of food prepared and consumed (e.g. high protein foods have higher nitrogen content), the use of garbage disposal units, left-over food handling and disposal practices, etc. The sewage generated by affluent neighborhoods has higher strength, measured by BOD and higher total nitrogen

[8]Table 2-9, page 27, Metcalf & Eddy, Inc., "Wastewater Engineering Treatment, Disposal and Reuse", revised by Tchobanoglous, G. and Burton, F., McGraw-Hill, 3rd Edition , 1991

concentrations. Domestic wastewater with levels of TN as high as 80 mg/L, are associated with residential affluence.[9] Considering affluence and other factors, Regional Board staff selected a septic tank influent value of 60 mg/L of nitrogen, a concentration exactly mid-range of nitrogen concentration values assigned to untreated domestic wastewater, which ranges between low (20 mg/L) medium (40 mg/L) and high (85 mg/L) strength.

Another source of nitrogen reduction occurs within a septic tank, especially when the septic tank is oversized for the wastewater volume and the retention time is several days. This nitrogen load reduction is called "in-tank denitrification" and it can reduce a large percentage of total nitrogen from the effluent. Also, ammonia nitrogen can be incorporated into microbial or plant biomass in the septic tank systems as well as in the subsurface effluent disposal zone given certain environmental conditions. In general, this is not considered a major mechanism for nitrogen removal from septic tanks, but the total nitrogen concentration in residential effluent in the Malibu Civic Center area was further reduced from 60 mg/L to 45 mg/L before calculating the total nitrogen load from residential OWTS. The value of 45 mg/L TN concentration reflects OWDS treatment and removal. Table 14-7,[10] indicates that the total nitrogen concentration in the septic tank effluent ranges from 25 mg/L to 60 mg/L. A nitrogen concentration of 45 mg/L for OWDS treated wastewater is mid-range of typical domestic wastewater strengths.

Formula Used for Calculation of Residential Nitrogen Loading

The same basic formula is used to calculate mass load of nitrogen from residential wastewater, but with no data or metering of the discharge volume, residential flow volume was estimated using, the number of bathrooms is multiplied by 100 gpd. Flow volume is converted to million gallons per day by multiplying (10^{-6}). Nitrogen load is calculated by multiplying flow volume by the effluent nitrogen concentration of 45mg/L and unit conversion values. The conversion factor of 8.345 is the result of carrying the conversion for the different units to pounds per day of nitrogen. The formula shown below shows the complete calculations described:

$$\begin{matrix} No.\ \ of \\ Bathrooms \end{matrix} \times 100\,gpd \times 3.7854\frac{L}{gal} \times \begin{matrix} Total \\ Nitrogen \end{matrix} \frac{mg}{L} \times 2.205x10^{-6}\frac{lb}{mg} = Nitrogen\,\frac{lb}{day}$$

iii. Summary of Total Nitrogen Loading from Commercial and Residential Sites

Staff's inventory of commercial wastewater flows in the Malibu Civic Center area consists of 25 permitted sites and 13 unpermitted sites. The total wastewater discharge volume released from these commercial properties is 128, 469 gallons per day (gpd). The total nitrogen load carried to groundwater by these wastewater discharges is 42.53 lbs/day or 15,422 lbs/year.

[9] **Rich Stowell, personal communication, Notes from State Board Training Academy training course "Wastewater Engineering 2, Volume 1, The Advanced Class," 2009.**

[10] Table 14-7, page 1040, Metcalf & Eddy, Inc., "Wastewater Engineering Treatment, Disposal and Reuse", revised by Tchobanoglous, G. and Burton, F., McGraw-Hill, 3rd Edition, 1991.

Total residential flow is 126,300 gpd and the total nitrogen load from residential sites is 47.429 lbs/day or 17,311 lbs/year.

Total nitrogen loading from commercial and residential wastewater is summarized in Table 1. Total flow of 255,000 gpd and total nitrogen loading of 89.7 lbs/day are used for both spreadsheet and numerical models to estimate the mass loading to Malibu Lagoon.

c. Modeling to Estimate Nitrogen Load to Malibu Lagoon

i. Numerical Model

Using an updated total nitrogen release of 89.7 lbs/d in the numerical fate and transport model, the estimation of wastewater derived nitrogen load transported by groundwater flow to the Lagoon is 28.7 lbs/day. When the estimated total nitrogen load is greater, the numerical model indicates load to the Lagoon is greater. Details of the numerical modeling approach to estimate mass loading to the Lagoon, using updated total nitrogen load, and older load assessments were prepared by Dr. C.P. Lai, and are appended to this Technical Memorandum #4 as Attachment 4-1.

ii. Spreadsheet Model by Flow Reduction via Geographic Sectors and Soil Reduction

Flow Reduction Factor

Flow portioning reduces the TN load reaching the Lagoon. Factors governing flow contribution include: wastewater discharge locations, surface topography, and groundwater contours, which control the direction of groundwater flow. Different proportions of the total wastewater discharged in each reach the Lagoon.

<u>Sector I</u> - consists of the Winter Canyon drainage and the bedrock highlands that extend above the western side of the Malibu Valley. Sector 1 corresponds to the Winter Canyon and West Alluvium areas described in the 2004 Stone Report. Exclusive of Pepperdine University, there are nine commercial wastewater discharges located in this sector. The wastewater discharged from the commercial facilities in Sector 1 is a mixture of treated and untreated wastewater and the total discharge volume is 51,737 gpd. There are 61 homes in Sector 1, discharging an estimated 17, 800 gpd of wastewater.

The highland area is bisected by Malibu Canyon Road and includes 61 homes and a portion of the Pepperdine University campus. Winter Canyon is not eroded to the depth of the Malibu Valley and thickness of the alluvium is less. Sector I is subdivided into two sub-sectors with significant differences in contribution to the Lagoon. The greatest volume of wastewater from Sector I is discharged in the Winter Canyon drainage, but the Winter Canyon flow is assumed to have a relatively low contribution (1%) to Malibu Lagoon. Most of the wastewater discharged in Winter Canyon is assumed to discharge to Malibu Beach.

Section I is divided into the Winter Canyon drainage and drainage from highland area southeast toward Malibu Valley. The division is based on topography. Wastewater in this sub-sector is discharged from mostly single family homes, private schools, nurseries, and the HRL facility. Flow is directed by topography southeast to the western edge of Malibu Valley and east toward Malibu Creek Canyon.

Regional Board staff assumed that the maximum contribution to the Lagoon from this sub-sector is 45% of the total flow. The fractured bedrock highlands outside of the Winter Canyon drainage have a thin veneer of soil. It has been assumed in some previous studies that all wastewater from septic discharges to this highland area flows into the alluvial sediments on the west-side of Malibu Valley. Where flow through the relatively impermeable alluvium is slow and travel times to the Lagoon of 30 years to 50 years. A portion of the wastewater flow from this highland sub-sector does enter the alluvium, as evidenced by the relatively high nitrogen concentrations and high bacteria found in the monitoring wells located near the Valley walls (e.g. monitoring wells located at the Mira Mar Properties on Stuart Ranch Road and behind the County Administration Center on Civic Center Way). Monitoring wells used for the Stone risk assessment study were all located in the alluvium of the Malibu Valley and none of the groundwater table contours extend to the bedrock highlands, which represent over 50% of the Malibu Civic Center area.

Groundwater takes the path of least resistance. It can be logically assumed that some portion of the septic wastewater will percolate down into the fractured bedrock, until it reaches the water table. Low permeability sediments are not recharged at high rates; flow is restricted. There should be sufficient hydrostatic head for groundwater flow through the highly fractured bedrock underlying the Valley. Unconfined, this groundwater will rise to potentiometric surface.

Malibu Water Company records and geologic reports[11] indicate that the deep and shallow alluvial aquifers in the Malibu Valley are recharged by groundwater in the fractured bedrock exposed in the surrounding highlands. All unconfined groundwater in the Malibu Civic Center area rises to the same potentiometric surface, a surface that slopes from the bedrock highlands to sea level. Groundwater in the bedrock highlands derived from rainfall, infiltration from septic discharges, and irrigation preferentially would not flow into relatively impermeable alluvial layers of silt and clay when high permeability sands, gravels, and fractured bedrock underlying the Malibu Valley provide a relative super highway for groundwater flow. Wells and borings adjacent to Malibu Creek have found very high permeability sands and gravels. Wells and borings adjacent to Malibu Creek have found very high permeability sands and gravels. There are no confining layers in this relatively coarse alluvium. These sediments have high conductivities and travel times of 400 feet a day (ft/d).

<u>Sector II</u> – Sector II consists of area along the west side of Malibu Creek including the residential area surrounding Serra Retreat and the surrounding highlands, which drain to

[11] Old records for the Malibu Water Company, owned and operated by the Adamson Family, are kept in storage at Mariposa Land Company, LLC, offices on Cross Creek Rd.

this area. In the Stone Environmental report, Sector II corresponds to the Malibu Tributary, Serra Retreat, North Alluvium, and East Alluvium areas. There is only one commercial facility located in Sector II; that is Serra Retreat with a relatively low wastewater discharge of 720 gpd. There are 83 homes located in this sector with an estimated wastewater discharge volume of 31,100 gpd.

Percolate from septic systems following topography flows toward Malibu Creek. Most of Malibu Water Company's water supply wells were located in this area. It was implied in previous nitrogen load studies that flow from the wastewater discharged into the thin alluvium draped over the bedrock highlands in this sector was confined to this thin soil layer until it reaches the alluvial sediments in the Valley. Alluvium adjacent to Malibu Creek on the east-side of Malibu Valley has very high conductivities, 400 ft/d, and travel times of less than one year for the alluvium in this area of the Malibu Valley were estimated in the (2004) Stone report[11]. Regional Board staff estimated that as much as 95% of the total wastewater flow from this sector reaches the Lagoon.

<u>Sector III</u> – Sector III consists of the relatively flat, gently sloping floor of Malibu Valley located north of Pacific Coast Highway. Sector III is generally described as the Malibu Civic Center area and most of the commercial development is located here. Many of these commercial facilities are located close to Malibu Creek and the Lagoon where the alluvial sediments have high conductivity. Travel time to Malibu Creek and the Lagoon for wastewater discharged in this area can be less than one day. Staff estimates 95% of the wastewater flow from this area reaches Malibu Creek and Lagoon. An exception to this high percentage of total flow is the wastewater discharged from two commercial properties located near the western edge of Malibu Valley. The (2004) Stone report found travel times to the Lagoon from this area can be as much as 50 years[12]. The Racquet Club and Miramar Properties are located in this area. It is estimated that only 20% of the wastewater discharged at these two sites reaches the Lagoon.

Only two homes with an estimated wastewater of 800 gpd are located in Sector III. There are 16 commercial facilities located in Sector III. An estimated 49,438 gpd, consisting of wastewater from both septic and advanced wastewater treatment systems, is discharged in Sector III.

<u>Sector IV</u> – Sector IV consists of commercial facilities located south of Pacific Coast Highway along Malibu Road and 180 homes located in Malibu Colony and Amarillo Beach. All of the wastewater generated at Malibu Colony Plaza, which encompasses all of the commercial facilities located between Malibu Road and Pacific Coast Highway, is pumped under Pacific Coast Highway to Winter Canyon for treatment and disposal and assigned to Sector 1. Most of the wastewater from commercial development in this sector is collected and treated in Winter Canyon. Only five commercial properties located in Sector IV are not connected to the Malibu Colony Plaza wastewater collection system. The collective, wastewater discharge from these commercial properties is only 2,140 gpd.

[12] Stone Environmental, Inc. "Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu, California", 2004.

There are 180 homes located in Sector IV. Wastewater, from the five commercial properties and most of the homes (107), discharges directly to the ocean and beaches north of Malibu Lagoon. A portion of the nutrient and bacteria load discharged to the beach can be transported with sediments toward the Lagoon by the prevailing long-shore movement of northwest to southeast. Once transported toward the Lagoon, it can enter the Lagoon through tidal inflow. The U.S. Environmental Protection Agency estimated that tidal inflow contributed only 1% of the nutrient load in Malibu Lagoon. Staff estimates that 1% of the 42,040 gpd of wastewater discharged in the main area of Sector IV could reach the Lagoon, but acknowledges the proportion could be much smaller.

There are alluvial sediments, estuary sediments, and beach sand beneath Sector IV. Both high and low permeability are found in this mixture of sand, silt and clay. Generally, nutrient removal by soil bacterial action would be high, but it is not because there is little separation between septic discharges and groundwater. Much of this coastal area has little elevation above sea level.

Sector IV has a sub-sector located near the Lagoon and subject to Lagoon tidal fluctuations. A collective wastewater flow of 25,700 gpd from 73 homes is assigned to the near Lagoon sub-sector. It is estimated that nearly 45% of the 25,700 gpd of the wastewater discharged in this sub-sector reaches the Lagoon.

Sector V – Sector V consists of a narrow coastal corridor located south of Malibu Lagoon and adjacent to Pacific Coast Highway and the Pacific Ocean. Sector V is smallest section and contributes little groundwater flow to the Malibu Lagoon. The topography of the area directs groundwater flow to the ocean. This area is described as the East Shore in the 2004 Stone Report. Bacteria and nitrogen from wastewater discharged directly to the ocean pollute the public beaches in this sector. Nitrogen and bacteria discharged to the beaches south of the Lagoon can be transported toward the Lagoon during short intervals when there is a southern swell, usually in the summer and early fall months when storm center highs are located to the south off the coast of Baja California. At such times, coastal long shore transport can reverse direction.

There are nine commercial facilities and 23 homes located in Sector V. The commercial wastewater discharge volume is estimated at 23,674 gpd. Three of the commercial facilities have advanced OWTS and thus, this volume is a mixture of septic and more treated wastewater. The estimated residential wastewater discharge volume from the 23 homes located in Sector V is 10,800 gpd.

Staff estimates a very small proportion of the wastewater discharged in Sector V, approximately 1% of the total flow, has a chance of being transported northward toward the Lagoon where it could be carried by tidal inflow.

Soil Treatment Reduction Factor

Soil Nitrogen Load Reduction Factor for Commercial Sites - Given sufficient separation between the point of wastewater effluent discharge and groundwater, soil bacteria can remove significant amounts of nitrogen. This soil bacteria activity is called "soil treatment". Another factor that influences the removal of nitrogen in the wastewater disposal zone is the soil composition and permeability. This characteristic of the soil is the reason that most permitting agencies require soil percolation testing. If the percolation is too fast (e.g. clean, coarse grained, uniform sand), wastewater flow through the near surface oxygenated zone does not allow time for nitrogen removal by soil bacteria. If the percolation rate is too slow (e.g. very fine soils with high clay content), subsurface disposal of wastewater may not be possible. Table 3 contains information on the depth to groundwater and soil type was utilized to estimate total nitrogen load reduction factors by "soil treatment" ranged from 0% to 20%.

No Soil Treatment Factor for Residential Sites - Permitting of OWDS for residential property is delegated to local agencies, and we do not have information on site-specific conditions needed to make an estimate a "soil treatment" or load reduction factor. Therefore, a nitrogen load reduction factor could not be applied to the nitrogen load estimated for residences located in the Malibu Civic Center area. It is known that many of the Malibu Colony residences lack adequate separation from groundwater. In addition, many residences in the highland sectors of the Malibu Civic Center area use seepage pits rather than leachfields for wastewater disposal. Nitrogen load reduction factors for soil bacteria activity are not applicable where seepage pits are used for wastewater disposal. Filtration of wastewater discharged into seepage pits located in soil or permeable bedrock will remove some bacteria load, but the nitrogen load carried in solution, is not removed by filtration.

Detail calculations for flow reduction and soil treatment reduction are summarized in Table 3.

3. Results

Using staff's loading factors for the numerical fate and transport model, staff estimates that wastewaters transport 29 lb/day into Malibu Lagoon. This model also indicates that loads are increasing. Details of this numerical modeling approach are in the Mass Loading Estimate prepared by Dr. C.P. Lai that is appended to Technical Memorandum #4 as Attachment 4-1.

Also, using the same load factors applied to the 'spreadsheet' model, which characterized the wastewater transport into five hydrogeologic sectors, staff estimates that wastewaters transport 36 lb/day into Malibu Lagoon.

Staff's estimates of 29 lb/day to 36 lb/day from the numerical and 'spreadsheet' models are above two of the estimates (17 lb/day to 20 lb/day) prepared by the third parties in previous studies and slightly overlap the estimate by the other third party (32 lb/day). Among the factors accounting for the range in estimates between staff's estimates and third-party estimates are:

- Commercial Flows: The third-party models used significantly lower assumptions of commercial wastewater flows.
- Residential Concentrations: Two of the three third-party models assumed that residential wastewaters have nitrogen concentrations that are about one-half of what staff assumed.
- Nitrogen concentration of commercial wastewater: The average nitrogen concentration of commercial wastewater discharges has decreased. Since 2004, 15 additional OWTS have been installed at commercial properties in the Malibu Civic Center area.

The ranges in estimates of nitrogen loads to the Lagoon and key factors are shown in the following Table 4:

	Third-Party Estimates			**Staff Estimates**	
	Stone (2004) Model	**Questa (2005) Model**	**Tetra Tech (2002)**	**Staff Numeric Model**	**Staff Spreadsheet Model**
Commercial Flow Rate (gal/day)	62,166	100,000	75,000	128, 469	128, 469
Commercial Concentration (mg/L)	50.0	50.0	59.2	3-110	3-110
Commercial Load (lb/day)	26	42	37	42.3	42.3
Residential Flow Rate (gal/day)	126,121	126,121	54,800	126,300	126,300
Residential Concentration (mg/L)	20.0	20.0	59.2	45	45
Residential Load (lb/day)	21	21	27	47.4	47.4
Ratio of Mass loading	36%	32%	50%	32%	38%
Gross Load released from OWDSs	47	63	64	89.7	89.7
Net Load to Malibu Lagoon	17	20	32	29	36

DRAFT AUG 5 2009

Regardless of differing assumptions and models used in the estimates, all estimates – including those prepared by staff as well as past estimates prepared by third parties – indicate that nitrogen loads from OWDSs are significantly above the waste load allocation of 6 lb/day established in a TMDL[13] adopted by the US EPA on March 21, 2003.

4. Conclusion

Staff has determined that OWDSs in the Malibu Civic Center area cumulatively release nitrogen at rates that contribute to eutrophication and impair aquatic life in Malibu Lagoon. This conclusion is supported by staff's estimates ranging from 29 lb/day to 36 lb/day as well as third-party estimates that range from 17 lb/day to 32 lb/day. All estimates are well above targets needed to restore water quality and protect beneficial uses in Malibu Lagoon.

---

[13] In the Malibu Creek Watershed Nutrient TMDL (March 21, 2003), the US EPA specifies a numeric target of 1.0 mg/l for total nitrogen during summer months (April 15 to November 15) and a numeric target of 8.0 mg/L for total nitrogen during winter months (November 16 to April 14). Significant sources of the nutrient pollutants include discharges of wastewaters from commercial, public, and residential landuse activities. The TMDL specifies load allocations for on-site wastewater treatment systems of 6 lbs/day during the summer months and 8 mg/L during winter months.

References:

California Division of Mines and Geology, 2001, “Seismic Hazard Zone Report for the Malibu Beach 7.5- Minute Quadrangle, Los Angeles, California”, Seismic Hazard Zone Report 050, dated 2001.

California Department of Water Resources, Bulletin 63-5, “Seawater Intrusion in California”, October 1965.

Crites, R. and Tchobanoglous. G., “Small and Decentralized Wastewater Management Systems” McGraw-Hill, 1998.

Dibblee, T. W., 1982, “Geology of Santa Monica Mountains and Simi Hills, Southern California” , pages 94-130, in Geology and Mineral Wealth of the California Transverse Ranges”, 1982.

Dibblee, T. W., “Geologic Map of the Malibu Beach Quadrangle, Los Angeles, California”, published by Dibblee Geological Foundation, 1993.

Fife, D. and Minch, J., eds., “Geology and Mineral Wealth of the California Transverse Ranges”, South Coast Geological Society, Inc., 1982.

Fugro West, Inc., 2005, “A Steady-State Groundwater Flow Model for the Proposed Malibu-La Paz Ranch Development, Project No. 3374.001.06, dated March 7, 2005.

Geosyntec Consultants, Inc., 2007, “Geotechnical Site Exploration and Intrepretation of Subsurface Conditions, Malibu Legacy Park Site”, Project No. LA0142-02, dated July 30, 2007.

Leighton and Associates, Inc. 1994, “Report of Geotechnical Studies for Planning Purposes in the Civic Center Area, City of Malibu, California”, Project No. 2920647-01, dated July 30, 2007.

Malibu Water Company, personal communication between Grant Adamson and Toni Callaway. The Adamson Family owned the Malibu Water Company. Records on water supply wells located in the lower Malibu Creek watershed, are stored at Mariposa Land Company, LLC, offices on Cross Creek Road (2009).

Metcalf & Eddy, Inc., “ Wastewater Engineering Treatment, Disposal and Reuse”, revised by Tchobanoglous, G. and Burton, F., McGraw-Hill, 3rd Edition, 1991.

Metcalf & Eddy, Inc., “Wastewater Engineering. Treatment and Reuse” McGraw-Hill, 4th Edition, 2003.

Salvato, J. A., 1982, “Environmental Engineering and Sanitation”, John Wiley & Sons. 1982.

Stone Environmental, Inc., 2004, “Final Report, Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu, California”, Project No. 011269-W, dated August 30, 2004.

Stowell, R., personal communication, Notes from State Board Training Academy training course "Wastewater Engineering 2, Volume 1, The Advanced Class,"2009.

Tetra Tech, Inc., 2001, "Nutrient and Coliform Modeling for the Malibu Creek Watershed TMDL Studies", prepared for U.S. Environmental Protection Agency, Region 9 and the Los Angels Regional Water Quality Control Board, dated May 22, 2001.

U.S. Environmental Protection Agency, 2003, "Total Maximum Daily Loads for Nutrients Malibu Creek Watershed", 2003.

U.S. Environmental Protection Agency, 2002, "On-site Wasterwater Treatment Systems Manual", 2002.

URS Greiner Woodward Clyde, 1999, "Study of Potential Water Quality Impacts on Malibu Creek and Lagoon From On-Site Septic Systems". Project No. 964P170, dated June 7, 1999.

Van Beveren & Butelo, Inc., 2007, "Report of Geotechnical Investigation, Proposed Remodeling of Malibu Lumber Facility", Project No. 07-020, dated July 26, 2007.

Van Beveren & Butelo, Inc., 2007, "Report of Hydrologic Study, Proposed Legacy Park Discharge Area", Project No. 07-020.2, dated September 26, 2007.

Map 1 – Malibu Civic Center Area

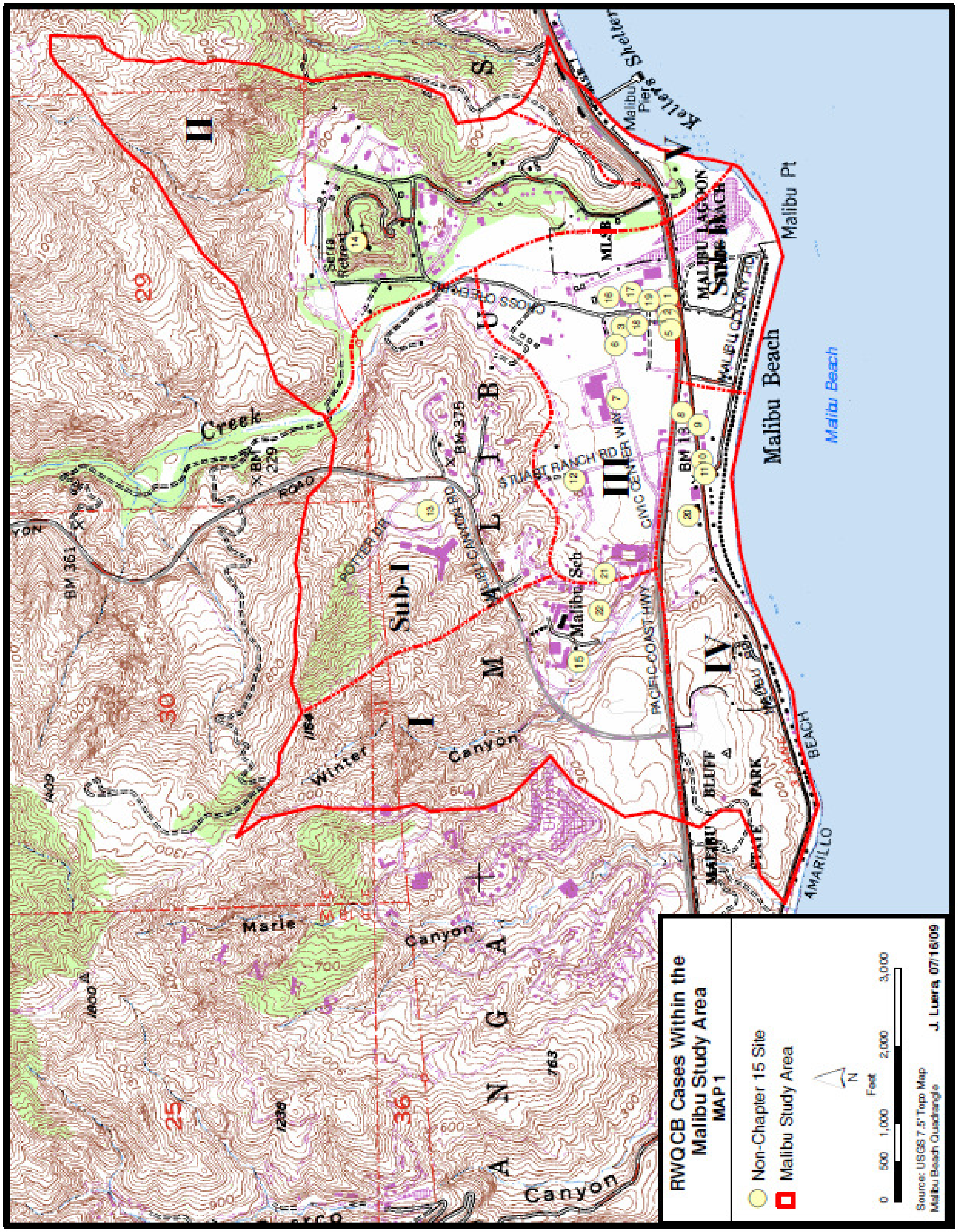
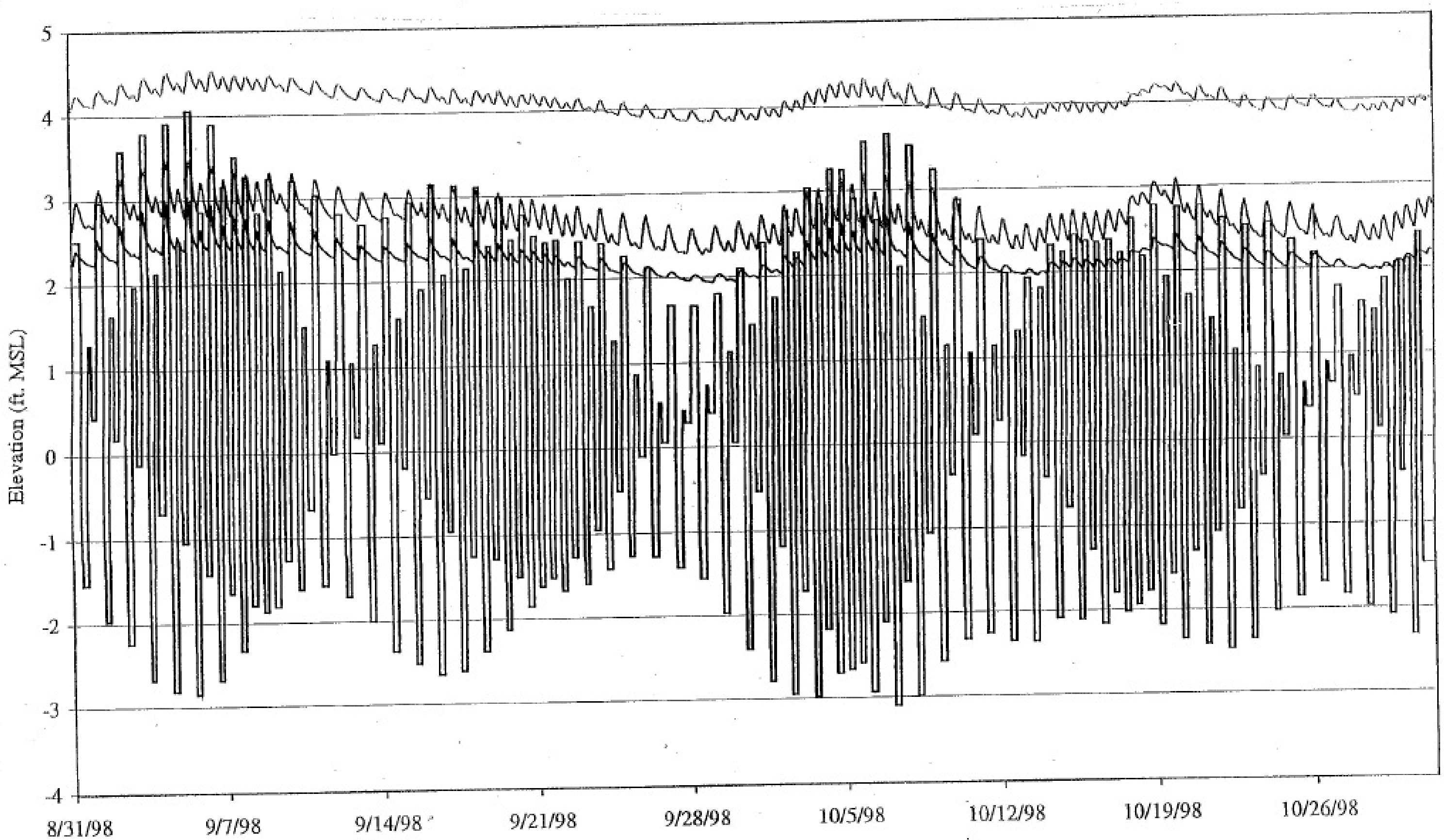


Figure – 1
Correlation of Groundwater and Tidal Levels



Notes: Malibu Creek flowing to ocean during monitored period.
Period when aquifer testing undertaken not included.

Figure -1 Adapted from Figure 4-1 in "Study of Potential Water Quality Impacts on Malibu Creek and Lagoon from On-site Septic Systems", 1999, URS Greiner Woodward Clyde

Table 1 – continue to next page

Table 1 commercial and residential nitorgen loading

Sector 1	Gallons per Day	Effluent Concentration of Nitrogen (mg/L)	Nitrogen Effluent Load to Study Area (lbs/day)	Nitrogen Efffluent Load to Study Area (lbs/year)
HRL^ -3011 Malibu Cyn Rd	3,428	45.0	1.287	469.86
L.A. Co. Main. Yard -3637 Winter Cyn Rd	252	40.0	0.084	30.70
*Malibu Colony Plaza^^ -Disposal in Winter Cyn	16,617	18.1	2.510	916.12
Malibu WPCP^^ -3260 Vista Pacifica	22,500	20.4	3.830	1,398.08
Webster Elementary^ -3602 Winter Cyn Rd	5,000	75.0	3.129	1,142.22
Our Lady of Malibu^ -3625 Winter Cyn Rd	2,500	75.0	1.565	571.11
Malibu Presbyterian Nursery School - 3324 Malibu Cyn Rd	1,500	75.0	0.939	342.67
Commercial - 7 Business Facilities	51,797		13.345	4,870.76
Residential 61 homes	17,800	45.0	6.684	2,439.79
Total			20.029	7,310.55

*The value of 18.1 for Malibu Colony Plaza was calculated from the 2nd Quarter 2007 to 2nd Quarter 2008 monitoring reports.
^ Assumed cafeteria food waste
^^ Advanced OWTS

Sector 2	Gallons per Day	Effluent Concentration of Nitrogen (mg/L)	Nitrogen Effluent Load to Study Area (lbs/day)	Nitrogen Efffluent Load to Study Area (lbs/year)
Serra Retreat^ -3401 Serra Rd	720	60.0	0.361	131.58
Commercial - 1 Business Facility	720		0.361	131.58
Residential 83 homes	31,100	45.0	11.679	4,262.77
Total			12.039	4,394.36

^ Retreat and conference center with food service - low utilization

Sector 3	Gallons per Day	Effluent Concentration of Nitrogen (mg/L)	Nitrogen Efffluent Load to Study Area (lbs/day)	Nitrogen Efffluent Load to Study Area (lbs/year)
Malibu Animal Hospital -23431 PCH	500	40.0	0.167	60.92
Malibu Adm. Center -23519 Civic Ctr Wy	4,038	40.0	1.348	491.98
Raquet Club -23847 Stuart Ranch Rd	1,500	75.0	0.939	342.67
Prudential Realty -23405 PCH	450	40.0	0.150	54.83
Malibu Country Mart I^ -3835 Cross Creek Rd	8,400	80.0	5.608	2,046.86
Malibu Country Mart II^ 23410 Civic Ctr Wy	6,300	80.0	4.206	1,535.15
Malibu Country Mart III^ -3900 Cross Creek Rd	3,400	80.0	2.270	828.49
Malibu Shell^^ -23387 PCH	300	4.2	0.011	3.84
Malibu Prof. Arts Bldg -23440 Civic Ctr Wy	450	40.0	0.150	54.83
Malibu Lumber^^ -23479 PCH	8,500	5.7	0.404	147.58
Mira Mar Properties -23805-23815 Stuart Ranch Rd	3,200	40.0	1.068	389.88
J & P Limited -3806 Cross Creek Rd	500	40.0	0.167	60.92
So. Calif. Edison	400	40.0	0.134	48.73
Verizon South, Inc. -3705 Cross Creek Rd	400	40.0	0.134	48.73
Mariposa Land Company, LLC -3728 Cross Creek Rd	400	40.0	0.134	48.73
Malibu Creek Plaza/Malibu Village^^	11,000	3.0	0.275	100.52
Commercial - 16 Business Facilities	49,738		17.163	6,264.65
Residential 2 homes	800	45.0	0.300	109.65
Total			17.464	6,374.30

^ Influent expected high level of Total Nitrogen (TN), but effluent level of TN reduced by weekly pumping of septic tanks

^^ Advanced OWTS

Sector 4	Gallons per Day	Effluent Concentration of Nitrogen (mg/L)	Nitrogen Effluent Load to Study Area (lbs/day)	Nitrogen Effluent Load to Study Area (lbs/year)
Malibu Rd., LLC -23676-23712 Malibu Rd	400	40.0	0.134	48.73
Morton-Gerson -23730 Malibu Rd	400	40.0	0.134	48.73
L.A. Co. Fire Station #88 -23720 Malibu Rd	540	30.0	0.135	49.34
Lisa Krasnoff -23655 Malibu Colony Rd	400	40.0	0.134	48.73
Mesa, LLC 23915 PCH	400	40.0	0.134	48.73
Commercial - 5 Business Facilities	2,140		0.669	244.28
Residential 180 homes	65,800	45.0	24.710	9,018.98
Total			25.379	9,263.27

*187 homes were counted in Sector 4 with a total calculated flow of 65600 gpd

Sector 5	Gallons per Day	Effluent Concentration of Nitrogen (mg/L)	Nitrogen Effluent Load to Study Area (lbs/day)	Nitrogen Effluent Load to Study Area (lbs/year)
Surfrider Co. Beach -23060 PCH	3,188	40.0	1.064	388.42
Malibu Pier State Park^^ -23000 PCH	3,000	11.7	0.293	106.91
Malibu Shores Motel^ -23033 PCH	2,843	60.0	1.423	519.57
Malibu Beach Inn^^ -22878 PCH	2,843	31.9	0.757	276.24
Jack-in-the-Box^^ -23017 PCH	4,500	26.26	0.986	359.94
Malibu Plaza 22917 PCH	1,500	40.0	0.501	182.76
Malibu Inn & Restaurant^ 22969 PCH	6,200	110.0	5.691	2,077.32
Surfshack/Fish Grill -22935 PCH	400	80.0	0.267	97.47
Spic & Span Cleaners/Chabad -22941 PCH	400	40.0	0.134	48.73
Commercial - 9 Business Facilities	24,074		10.715	3,911.16
Residential 23 homes	10,800	45.0	4.056	1,480.32
Total			14.771	5,391.48

^ Effluent assumed to have high TN because of low septic tank retention time

^^these facilities have package advanced OWTS

Study Area	Gallons per Day	Effluent Concentration of Nitrogen (mg/L)	Nitrogen Effluent Load to Study Area (lbs/day)	Nitrogen Effluent Load to Study Area (lbs/year)
Commercial	128,469		42.253	15,422.43
Residential	126,300		47.429	17,311.51
Total	254,769		89.682	32,733.94

DRAFT AUG 5 2009

Table 2 –List of Residential Septic Systems

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
I	4458027034	3547 Malibu Colony Rd	Multi Family	6	3	On-site
I	4458026007	3400 Coast View Dr	Residential	4		On-site
I	4458027002	3401 Coast View Dr	Residential	4	4	On-site
I	4458026006	3436 Coast View Dr	Residential	2	2	On-site
I	4558026015	3502 Coast View Dr	Residential	4	3	On-site
I	4458026014	3504 Coast View Dr	Residential	3	4	On-site
I	4458026004	3524 Coast View Dr	Residential	3	3	On-site
I	4458026003	3536 Coast View Dr	Residential	2	2	On-site
I	4458027030	Coast View Dr	Residential			On-site
I	4458025020	3207 Colony View Cir	Residential	3	3	On-site
I	4458025016	3213 Colony View Cir	Residential	4	4	On-site
I	4458025015	3215 Colony View Cir	Residential	3	4	On-site
I	4458025012	3216 Colony View Cir	Residential	3	4	On-site
I	4458025010	3217 Colony View Cir	Residential	3	2	On-site
I	4458025011	3220 Colony View Cir	Residential	3	3	On-site
I	4458025025	3211 Colony View Cir	Residential	5	5	On-site
I	4458024004	32701 Harbor Vista Dr	Residential	3	3	On-site
I	4458024043	23702 Harbor Vista Dr	Residential	3	2	On-site
I	4458024025	23704 Harbor Vista Dr	Residential	4	3	On-site
I	4458024031	23706 Harbor Vista Dr	Residential	3	2	On-site
I	4458024001	23708 Harbor Vista Dr	Residential	3	2	On-site
I	4458024029	23721 Harbor Vista Dr	Residential	3	3	On-site
I	4458025014	23722 Harbor Vista Dr	Residential	3	4	On-site
I	4458024034	23741 Harbor Vista Dr	Residential	3	2	On-site
I	4458025013	23748 Harbor Vista Dr	Residential	3	3	On-site
I	4458024009	23803 Harbor Vista Dr	Residential	6	7	On-site
I	4458025019	23812 Harbor Vista Dr	Residential	3	2	On-site
I	4458024010	23813 Harbor Vista Dr	Residential	3	2	On-site
I	4458024011	23831 Harbor Vista Dr	Residential	5	4	On-site
I	4458024012	23837 Harbor Vista Dr	Residential	3	1	On-site
I	4458025024	23838 Harbor Vista Dr	Residential	5	6	On-site
I	4458025006	23850 Harbor Vista Dr	Residential	3	3	On-site
I	4458025018	23858 Harbor Vista Dr	Residential	3	3	On-site
I	4458024013	23843 Harbor Vista Dr	Residential	3	2	On-site
I	4458025017	3224 Malibu Canyon Rd	Residential	2	2	On-site
I	4458025004	3338 Malibu Canyon Rd	Residential			On-site
I	4458024038	23800 Malibu Crest Dr	Residential	4	3	On-site
I	4458024042	23805 Malibu Crest Dr	Residential	4	4	On-site
I	4458024041	23806 Malibu Crest Dr	Residential	5	6	On-site

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
I	4458024039	23808 Malibu Crest Dr	Residential	3	2	On-site
I	4458024040	23812 Malibu Crest Dr	Residential	3	4	On-site
I	4458024022	23814 Malibu Crest Dr	Residential	4	5	On-site
I	4458024023	23816 Malibu Crest Dr	Residential	3	2	On-site
I	4458024021	23854 Malibu Crest Dr	Residential	2	3	On-site
I	4458024015	23870 Malibu Crest Dr	Residential	3	4	On-site
I	4458024014	23880 Malibu Crest Dr	Residential	4	4	On-site
I	4458026010	23901 Malibu Knolls Rd	Residential	4	1	On-site
I	4458026011	23903 Malibu Knolls Rd	Residential	4	3	On-site
I	4458026012	23905 Malibu Knolls Rd	Residential	3	2	On-site
I	4458026013	23907 Malibu Knolls Rd	Residential	3	3	On-site
I	4458026009	23908 Malibu Knolls Rd	Residential	3	3	On-site
I	4458025001	23915 Malibu Knolls Rd	Residential	3	2	On-site
I	4458026008	23916 Malibu Knolls Rd	Residential	4	4	On-site
I	4458025022	23933 Malibu Knolls Rd	Residential	2	2	On-site
I	4458027904	Winter Canyon Rd	Multi-Family			
I	4458027025	3625 Winter Canyon Rd	Residential	6	6	On-site
I	4458027003	3431 Coast View Dr	Residential	3	2	On-site
I	4458027004	3453 Coast View Dr	Residential	5	5	On-site
I	4458027005	3505 Coast View Dr	Residential	4	3	On-site
I	4458027029	3525 Coast View Dr	Residential	3	3	On-site
subtotal			61	198	178	
II	4452015035	3501 Cross Creek LN	Residential	4	4	On-site
II	4452015034	3509 Cross Creek LN	Residential	3	4	On-site
II	4452015023	3510 Cross Creek LN	Residential	4	4	On-site
II	4452015033	3511 Cross Creek LN	Residential	5	6	On-site
II	4452015025	3512 Cross Creek LN	Residential	3	4	On-site
II	4452015026	3520 Cross Creek LN	Residential			On-site
II	4452015031	3535 Cross Creek LN	Residential	4	4	On-site
II	4452015027	3538 Cross Creek LN	Residential	4	3	On-site
II	4452015030	3539 Cross Creek LN	Residential	4	4	On-site
II	4452015042	3550 Cross Creek LN	Residential	5	4	On-site
II	4452014006	3415 Cross Creek Rd	Residential	3	3	On-site
II	4452015024	Cross Creek LN	Residential	5	5	On-site
II	4458023003	3469 Cross Creek Rd	Residential	4	9	On-site
II	4458023009	3515 Cross Creek Rd	Residential	4	4	On-site
II	4452015029	3551 Cross Creek LN	Residential			On-site
II	4458022021	3565 Cross Creek Rd	Residential	4	3	On-site
II	4458022004	Cross Creek Rd	Residential			On-site
II	4458022003	3661 Cross Creek Rd	Residential	2	2	On-site
II	4452015003	23110 Mariposa De Oro St	Residential	5	5	On-site

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
II	4452015014	2311 Mariposa De Oro St	Residential	3	3	On-site
II	4452015007	23122 Mariposa De Oro St	Residential	4	4	On-site
II	4452015010	23140 Mariposa De Oro St	Residential	5	4	On-site
II	4452015040	23146 Mariposa De Oro St	Residential	6	5	On-site
II	4452015006	23155 Mariposa De Oro St	Residential	4	5	On-site
II	4452015036	23160 Mariposa De Oro St	Residential	2	1	On-site
II	4452015021	23210 Mariposa De Oro St	Residential	5	5	On-site
II	4452015020	23215 Mariposa De Oro St	Residential	3	2	On-site
II	4452015022	23222 Mariposa De Oro St	Residential	5	5	On-site
II	4452015019	23233 Mariposa De Oro St	Residential	3	3	On-site
II	4452015018	23255 Mariposa De Oro St	Residential	5	5	On-site
II	4452027018	23247 Palm Canyon Ln	Residential	5	6	On-site
II	4452027016	23267 Palm Canyon Ln	Residential	2	2	On-site
II	4452027013	23301 Palm Canyon Ln	Residential	4	7	On-site
II	4452027012	23333 Palm Canyon Ln	Residential	3	4	On-site
II	4452027011	23333 Palm Canyon Ln	Residential	6	5	On-site
II	4452014004	23344 Palm Canyon Ln	Residential	4	3	On-site
II	4452012028	23500 Palm Canyon Ln	Residential	5	5	On-site
II	4452027021	3200 Retreat Ct	Residential	8	8	On-site
II	4452027022	3201 Retreat Ct	Residential	6	7	On-site
II	4452027019	3210 Retreat Ct	Residential	5	6	On-site
II	4452027023	3211 Retreat Ct	Residential	5	6	On-site
II	4452026008	3216 Serra Rd	Residential	5	5	On-site
II	4452026009	3220 Serra Rd	Residential	4	3	On-site
II	4452026007	3226 Serra Rd	Residential	5	5	On-site
II	4452026006	3226 Serra Rd	Residential			On-site
II	4452026010	3250 Serra Rd	Residential	4	6	On-site
II	4452026011	3264 Serra Rd	Residential	5	5	On-site
II	4452026019	3268 Serra Rd	Residential	4	4	On-site
II	4452026018	3270 Serra Rd	Residential			On-site
II	4452026012	3314 Serra Rd	Residential	4	3	On-site
II	4452026013	3350 Serra Rd	Residential	5	4	On-site
II	4452026016	3410 Serra Rd	Residential	5	4	On-site
II	4452026014	3426 Serra Rd	Residential	4	3	On-site
II	4452026015	3434 Serra Rd	Residential	4	4	On-site
II	4452018006	3611 Serra Rd	Residential	4	3	On-site
II	4452026003	Serra Rd	Residential			On-site
II	4452018011	3549 Serra Rd	Residential	3	3	On-site
II	4452013001	3556 Serra Rd	Residential	4	3	On-site
II	4452018012	3557 Serra Rd	Residential	3	3	On-site
II	4452013002	3560 Serra Rd	Residential	3	2	On-site
II	4452018013	3567 Serra Rd	Residential	4	4	On-site
II	4452013003	3574 Serra Rd	Residential	6	7	On-site

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
II	4452018015	3609 Serra Rd	Residential	2	3	On-site
II	4452013009	3610 Serra Rd	Residential	4	4	On-site
II	4452018008	3615 Serra Rd	Residential			On-site
II	4452018016	3621 Serra Rd	Residential	4	4	On-site
II	4452018009	3623 Serra Rd	Residential	4	2	On-site
II	4452018017	3625 Serra Rd	Residential	4	2	On-site
II	4452018018	3627 Serra Rd	Residential	5	4	On-site
II	4452018019	3629 Serra Rd	Residential	4	3	On-site
II	4452018020	3631 Serra Rd	Residential	5	4	On-site
II	4452012014	3633 Serra Rd	Residential	4	4	On-site
II	4452012012	3635 Serra Rd	Residential	3	3	On-site
II	4452012015	3637 Serra Rd	Residential	1	1	On-site
II	4452013005	3644 Serra Rd	Residential	4	7	On-site
II	4452017001	3700 Serra Rd	Residential	4	3	On-site
II	4452012007	3701 Serra Rd	Residential	3	3	On-site
II	4452012016	3705 Serra Rd	Residential	4	3	On-site
II	4452012013	3707 Serra Rd	Residential	2	3	On-site
II	4452012022	3227 Serra Rd	Residential	4	4	On-site
II	4452012009	3737 Serra Rd	Residential	4	4	On-site
II	4452012011	3751 Serra Rd	Residential	3	4	On-site
II	4452012020	3811 Serra Rd	Residential	4	6	On-site
subtotal			83	309	311	

III	4452027010	3200 Cross Creek RD	Residential	3	3	On-site
III	4452027009	3232 Cross Creek RD	Residential	5	5	On-site
subtotal			2	8	8	

IV	4458004044	70 Malibu Colony Rd	Residential	4	3	On-site
IV	4452008025	112 Malibu Colony Rd	Residential	5	5	On-site
IV	4452008017	23314 Malibu Colony Rd	Residential	3	3	On-site
IV	4452008016	23316 Malibu Colony Rd	Residential	4	4	On-site
IV	4452008014	23318 Malibu Colony Rd	Residential	3	5	On-site
IV	4452008030	23324 Malibu Colony Rd	Residential	5	7	On-site
IV	4452010017	23325 Malibu Colony Rd	Residential	2	2	On-site
IV	4452008028	23330 Malibu Colony Rd	Residential	2	4	On-site
IV	4452010024	23331 Malibu Colony Rd	Residential	2	3	On-site
IV	4452008027	23334 Malibu Colony Rd	Residential	3	4	On-site
IV	4452010023	23337 Malibu Colony Rd	Residential			On-site
IV	4452008026	23338 Malibu Colony Rd	Residential	3	4	On-site
IV	4452008024	23346 Malibu Colony Rd	Residential	3	2	On-site
IV	4452010032	23349 Malibu Colony Rd	Residential	4	4	On-site
IV	4452008023	23350 Malibu Colony Rd	Residential	4	4	On-site
IV	4452010031	23351 Malibu Colony Rd	Residential	3	3	On-site

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
IV	4452008022	23354 Malibu Colony Rd	Residential	2	3	On-site
IV	4452008021	23356 Malibu Colony Rd	Residential	3	3	On-site
IV	4452008020	23360 Malibu Colony Rd	Residential	3	4	On-site
IV	4452010012	23401 Malibu Colony Rd	Residential	4	6	On-site
IV	4452008019	23402 Malibu Colony Rd	Residential	6	4	On-site
IV	4452009027	23410 Malibu Colony Rd	Residential	3	3	On-site
IV	4452009017	23416 Malibu Colony Rd	Residential	4	3	On-site
IV	4452009016	23418 Malibu Colony Rd	Residential	3	4	On-site
IV	4452010008	23425 Malibu Colony Rd	Residential	3	4	On-site
IV	4452009024	23426 Malibu Colony Rd	Residential	4	4	On-site
IV	4452010028	23431 Malibu Colony Rd	Residential	4	4	On-site
IV	4452010009	23435 Malibu Colony Rd	Residential			On-site
IV	4452009018	23438 Malibu Colony Rd	Residential	4	6	On-site
IV	4452009019	23440 Malibu Colony Rd	Residential	5	6	On-site
IV	4452010029	23441 Malibu Colony Rd	Residential	4	3	On-site
IV	4452009022	23444 Malibu Colony Rd	Residential	4	3	On-site
IV	4452010027	23445 Malibu Colony Rd	Residential	5	3	On-site
IV	4452009021	23446 Malibu Colony Rd	Residential	5	4	On-site
IV	4452010005	23449 Malibu colony Rd	Residential	3	5	On-site
IV	4452009020	23450 Malibu Colony Rd	Residential	4	6	On-site
IV	4452009015	23456 Malibu Colony Rd	Residential	3	4	On-site
IV	4452010003	23457 Malibu Colony Rd	Residential	3	4	On-site
IV	4458004031	23460 Malibu Colony Rd	Residential	3	2	On-site
IV	4458004032	23500 Malibu Colony Rd	Residential	3	5	On-site
IV	4452010002	23501 Malibu Colony Rd	Residential	2	1	On-site
IV	4452010019	23505 Malibu Colony Rd	Residential	4	4	On-site
IV	4458004033	23506 Malibu Colony Rd	Residential	2	4	On-site
IV	4458004034	23510 Malibu Colony Rd	Residential	3	3	On-site
IV	4458003023	23511 Malibu Colony Rd	Residential	3	2	On-site
IV	4458004035	23512 Malibu Colony Rd	Residential	4	4	On-site
IV	4458003022	23515 Malibu Colony Rd	Residential	5	5	On-site
IV	4458004036	23516 Malibu Colony Rd	Residential	3	2	On-site
IV	4458003021	23517 Malibu Colony Rd	Residential	3	2	On-site
IV	4458004037	23520 Malibu Colony Rd	Residential	4	5	On-site
IV	4458004038	23524 Malibu Colony Rd	Residential	4	5	On-site
IV	4458004039	23526 Malibu Colony Rd	Residential	5	7	On-site
IV	4458004040	23530 Malibu Colony Rd	Residential	4	4	On-site
IV	4458003019	23531 Malibu Colonr Rd	Residential	4	5	On-site
IV	4458003018	23533 Malibu colony rd	Residential	4	3	On-site
IV	4458004041	23536 Malibu colony rd	Residential	4	3	On-site
IV	4458004042	23538 Malibu Colony Rd	Residential	5	4	On-site
IV	4458003017	23543 Malibu Colony Rd	Residential	5	3	On-site
IV	4458004043	23544 Malibu Colony Rd	Residential	5	4	On-site

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
IV	4458003015	23555 Malibu Colony Rd	Residential	1	1	On-site
IV	4458004046	23556 Malibu Colony Rd	Residential	2	2	On-site
IV	4458004047	23560 Malibu Colony Rd	Residential	4	4	On-site
IV	4458003014	23561 Malibu Colony Rd	Residential	5	4	On-site
IV	4458004048	23562 Malibu Colony Rd	Residential	4	5	On-site
IV	4458004049	23566 Malibu Colony Rd	Residential	3	1	On-site
IV	4458003013	23567 Malibu Colony Rd	Residential	3	2	On-site
IV	4458004050	23570 Malibu Colony Rd	Residential	5	3	On-site
IV	4458004051	23600 Malibu Colony Rd	Residential	2	3	On-site
IV	4458003012	23601 Malibu Colony Rd	Residential			On-site
IV	4458004052	23604 Malibu Colony Rd	Residential	2	3	On-site
IV	4458004053	23608 Malibu Colony Rd	Residential	4	5	On-site
IV	4458004054	23610 Malibu Colony Rd	Residential	5	6	On-site
IV	4458003027	23611 Malibu Colony Rd	Residential	4	6	On-site
IV	4458004055	23614 Malibu Colony Rd	Residential	4	5	On-site
IV	4458003026	23615 Malibu Colony Rd	Residential	4	5	On-site
IV	4458005040	23618 Malibu Colony Rd	Residential	4	5	On-site
IV	4458005039	23620 Malibu Colony Rd	Residential	3	7	On-site
IV	4458005038	23622 Malibu Colony Rd	Residential	7	4	On-site
IV	4458003009	23623 Malibu Colony Rd	Residential	3	3	On-site
IV	4458005037	23626 Malibu Colony Rd	Residential	4	5	On-site
IV	4458003008	23629 Malibu Colony Rd	Residential			On-site
IV	4458005036	23630 Malibu Colony Rd	Residential	4	3	On-site
IV	4458005035	23632 Malibu Colony Rd	Residential	5	3	On-site
IV	4458005034	23634 Malibu Colony Rd	Residential	4	5	On-site
IV	4458003030	23639 Malibu Colony Rd	Residential	2	2	On-site
IV	4458005033	23640 Malibu Colony Rd	Residential	3	4	On-site
IV	4458003004	23641 Malibu Colony Rd	Residential			On-site
IV	4458005032	23644 Malibu Colony Rd	Residential	5	6	On-site
IV	4458005031	23648 Malibu Colony Rd	Residential	3	4	On-site
IV	4458003029	23649 Malibu Colony Rd	Residential	4	4	On-site
IV	4458005030	23652 Malibu Colony Rd	Residential	3	2	On-site
IV	4458005029	23654 Malibu Colony Rd	Residential	4	4	On-site
IV	4458003028	23655 Malibu Colony Rd	Residential	3	3	On-site
IV	4458005028	23660 Malibu Colony Rd	Residential	4	5	On-site
IV	4458002014	23661 Malibu Colony Rd	Residential	5	5	On-site
IV	4458005027	23664 Malibu Colony Rd	Residential	3	2	On-site
IV	4458002011	23667 Malibu Colony Rd	Residential	3	3	On-site
IV	4458005026	23668 Malibu Colony Rd	Residential	3	2	On-site
IV	4458005025	23672 Malibu Colony Rd	Residential	4	5	On-site
IV	4458002010	23673 Malibu Colony Rd	Residential	4	2	On-site
IV	4458005024	23674 Malibu Colony Rd	Residential	3	4	On-site
IV	4458005023	23678 Malibu Colony Rd	Residential	6	6	On-site

IV	4458005022	23684 Malibu Colony Rd	Residential	4	3	On-site
IV	4458002006	23687 Malibu Colony Rd	Residential	5	4	On-site
IV	4458005021	23700 Malibu Colony Rd	Residential	8	8	On-site
IV	4458006041	23704 Malibu Colony Rd	Residential	6	3	On-site
IV	4458002004	23705 Malibu Colony Rd	Residential	4	5	On-site
IV	4458006040	23708 Malibu Colony Rd	Residential	5	5	On-site
IV	4458002003	23709 Malibu Colony Rd	Residential	4	3	On-site
IV	4458006038	23712 Malibu Colony Rd	Residential	6	7	On-site
IV	4458002017	23713 Malibu Colony Rd	Residential	2	1	On-site
IV	4458006037	23716 Malibu Colony Rd	Residential	5	4	On-site
IV	4458006036	23720 Malibu Colony Rd	Residential	2	3	On-site
IV	4458006035	23730 Malibu Colony Rd	Residential	5	5	On-site
IV	4458006034	23736 Malibu Colony Rd	Residential	4	4	On-site
IV	4452005025	23006 Malibu Rd	Residential	3	3	On-site
IV	4458004045	23554 Malibu Rd	Residential	3	2	
IV	4458006033	23740 Malibu Rd	Residential	5	4	On-site
IV	4458006032	23746 Malibu Rd	Residential	4	3	On-site
IV	4458006031	23750 Malibu Rd	Residential	4	5	On-site
IV	4458006030	23752 Malibu Rd	Residential	4	4	On-site
IV	4458006029	23754 Malibu Rd	Residential	4	4	On-site
IV	4458006028	23758 Malibu Rd	Residential	3	4	On-site
IV	4458006027	23762 Malibu Rd	Residential	3	4	On-site
IV	4458006026	23764 Malibu Rd	Residential	3	5	On-site
IV	4458006025	23768 Malibu Rd	Residential	3	4	On-site
IV	4458006023	23800 Malibu Rd	Residential	9	10	On-site
IV	4458006022	23808 Malibu Rd	Residential	4	4	On-site
IV	4458007028	23812 Malibu Rd	Residential	4	1	On-site
IV	4458007027	23816 Malibu Rd	Residential	2	3	On-site
IV	4458007026	23822 Malibu Rd	Residential	4	7	On-site
IV	4458007025	23826 Malibu Rd	Residential	4	3	On-site
IV	4458007024	23832 Malibu Rd	Residential	5	3	On-site
IV	4458007023	23834 Malibu Rd	Residential	2	3	On-site
IV	4458007022	23844 Malibu Rd	Residential	3	2	On-site
IV	4458007021	23850 Malibu Rd	Residential	7	5	On-site
IV	4458007016	23858 Malibu Rd	Residential	5	6	On-site
IV	4458007015	23864 Malibu Rd	Residential			On-site
iV	4458007020	23868 Malibu Rd	Residential	5	6	On-site
IV	4458007019	23872 Malibu Rd	Residential	3	2	On-site
IV	4458007018	23900 Malibu Rd	Residential	3	2	On-site
IV	4458007017	23910 Malibu Rd	Residential	3	6	On-site
IV	4458008017	23917 Malibu Rd	Residential	5	4	On-site
IV	4458008016	23920 Malibu Rd	Residential	5	7	On-site
IV	4458008015	23926 Malibu Rd	Residential	6	5	On-site
IV	4458008014	23930 Malibu Rd	Residential	4	5	On-site
IV	4458008013	23936 Malibu Rd	Residential	4	4	On-site

IV	4458008018	23940 Malibu Rd	Residential	6	7	On-site
IV	4458008003	23950 Malibu Rd	Residential	4	5	On-site
IV	4458008002	23952 Malibu Rd	Residential	2	3	On-site
IV	4458008001	23956 Malibu Rd	Residential	5	3	On-site
IV	4458009013	23962 Malibu Rd	Residential	3	2	On-site
IV	4458009012	24000 Malibu Rd	Residential	4	3	On-site
IV	4458009009	24016 Malibu Rd	Residential	3	3	On-site
IV	4458009001	24056 Malibu Rd	Residential	2	1	On-site
IV	4458010015	24058 Malibu Rd	Residential	4	2	On-site
IV	4458010016	24102 Malibu Rd	Residential	4	4	On-site
IV	4458010017	24108 Malibu Rd	Residential	3	4	On-site
IV	4458010019	24116 Malibu Rd	Residential	3	3	On-site
IV	4458010018	24116 Malibu Rd	Residential	3	3	On-site
IV	4458010012	24120 Malibu Rd	Residential	3	3	On-site
IV	4458010011	24124 Malibu Rd	Residential	2	2	On-site
IV	4458010010	24128 Malibu Rd	Residential	3	4	On-site
IV	4458010008	24134 Malibu Rd	Residential	2	3	On-site
IV	4458010007	24138 Malibu Rd	Residential	3	3	On-site
IV	4458010006	24142 Malibu Rd	Residential	2	2	On-site
IV	4458010005	24146 Malibu Rd	Residential	4	4	On-site
IV	4458010004	24150 Malibu Rd	Residential	4	3	On-site
IV	4458010003	24154 Malibu Rd	Residential	2	2	On-site
IV	4458010001	24172 Malibu Rd	Residential	3	2	On-site
IV	4458011002	24212 Malibu Rd	Residential	2	2	On-site
IV	4458011003	24216 Malibu Rd	Residential	3	2	On-site
IV	4458018005	24001 Malibu Rd	Residential	3	3	On-site
IV	4458018020	24031 Malibu Rd	Residential	3	2	On-site
IV	4458018011	24109 Malibu Rd	Residential	3	2	On-site
IV	4458018012	24111 Malibu Rd	Residential	3	2	On-site
IV	4452008018	23406 Malibu Colony Rd	Residential	4	3	On-site
IV	4452009026	23414 Malibu Colony Rd	Residential	4	3	On-site
IV	4452009025	23422 Malibu Colony Rd	Residential	4	4	On-site
IV	4452009023	23430 Malibu Colony Rd	Residential	6	6	On-site
subtotal			180	651	658	

V	4452025006	3395 Sweetwater Mesa Rd	Residential	2	2	On-site
V	4452016004	3401 Sweetwater Mesa Rd	Residential	5	10	On-site
V	4452016019	3415 Sweetwater Mesa Rd	Residential	6	7	On-site
V	4452016020	3431 Sweetwater Mesa Rd	Residential	5	7	On-site
V	4452016007	3451 Sweetwater Mesa Rd	Residential	4	4	On-site
V	4452017004	3509 Sweetwater Mesa Rd	Residential	5	8	On-site
V	4452017005	3535 Sweetwater Mesa Rd	Residential	6	7	On-site
V	4452017009	3620 Sweetwater Mesa Rd	Residential	6	8	On-site
V	4452013008	3655 Sweetwater Mesa Rd	Residential	4	4	On-site
V	4452013007	3669 Sweetwater Mesa Rd	Residential	2	2	On-site

DRAFT AUG 5 2009

Section	AIN	Property Location	Property Use	Bed	Bath	System Type
V	4452016008	3330 Sweetwater Mesa Rd	Residential	4	3	On-site
V	4452016018	3362 Sweetwater Mesa Rd	Residential	4	3	On-site
V	4452016017	3380 Sweetwater Mesa Rd	Residential	4	3	On-site
V	4452016016	3416 Sweetwater Mesa Rd	Residential	3	3	On-site
V	4452016015	3464 Sweetwater Mesa Rd	Residential	4	4	On-site
V	4452017008	3556 Sweetwater Mesa Rd	Residential	6	6	On-site
V	4452005004	23018 Pacific Coast Hwy	Residential	3	3	On-site
V	4452005022	23022 Pacific Coast Hwy	Residential	2	2	On-site
V	4452005018	23030 Pacific Coast Hwy	Residential	2	2	On-site
V	4452005002	23034 Pacific Coast Hwy	Residential	2	2	On-site
V	4452005001	23038 Pacific Coast Hwy	Residential	3	2	On-site
V	4452019008	22931 Pacific Coast Hwy	Residential	2	3	On-site
V	4452005020	22860 Pacific Coast Hwy	Multi Family	12	13	On-site
subtotal			23	96	108	
TOTAL			349	1,262	1,263	

Table 3 - continue to next page

Table 3 Total Nitrogen Loading to the Lagoon After Adjustment of Flow and Leach Field Reduction

Sector 1	Discharge (gpd)	Estimated Percentage of Flow to Lagoon	Estimated Flow to Lagoon (gpd)	Effluent Concentration of Nitrogen (mg/L)	Depth to GW	Soil Type	Leach Field Reduction	Effluent Conc at the Lagoon (mg/L)	Nitrogen Load to the Lagoon (lb/day)
*HRL^ -3011 Malibu Cyn Rd	3,428	45%	1,542.6	45.0	>10	soil & bedrock	0%	45.0	0.58
L.A. Co. Main. Yard -3637 Winter Cyn Rd	252	1%	25.2	40.0	10	sand, silt & clay	20%	32.0	0.01
*Malibu Colony Plaza^^ -Disposal in Winter Cyn	16,617	1%	1,661.7	18.1	varies	sand & silt	0%	18.1	0.25
*Malibu WPCP^^ -3260 Vista Pacifica	22,500	1%	2,250.0	20.4	varies	sand & silt	0%	20.4	0.38
Webster Elementary^ -3602 Winter Cyn Rd	5,000	1%	500.0	75.0	15	sand & silt	20%	60.0	0.25
Our Lady of Malibu^ -3625 Winter Cyn Rd	2,500	1%	250.0	75.0		sand & silt	0%	75.0	0.16
Malibu Presbyterian Nursery School - 3324 Malibu Cyn Rd	1,500	45%	675.0	75.0		sand & silt	0%	75.0	0.42
Commercial - 7 Business Facilities	51,797		6,904.5						2.05
Residential 61 homes	17,800	45%	8,900.0	45.0				45.0	3.34
Total									5.39

*Seepage Pit Disposal or Failed Leachfield = 0% soil treatment
^Cafeteria food waste
^^these facilities have package advanced OWTS

Sector 2	Discharge (gpd)	Estimated Percentage of Flow to Lagoon	Estimated Flow to Lagoon (gpd)	Effluent Concentration of Nitrogen (mg/L)	Depth to GW	Soil Type	Leach Field Reduction	Effluent Conc at the Lagoon (mg/L)	Nitrogen Load to the Lagoon (lb/day)
Serra Retreat^ -3401 Serra Rd	720	95%	684.0	60.0	>10	sand & silt	20%	48.0	0.27
Commercial - 1 Business Facility	720		684.0						0.27
Residential 83 homes	31,100	95%	29,545.0	45.0				45.0	11.09
Total									11.37

^ Retreat and conference center with food service - low utilization

Sector 3	Discharge (gpd)	Estimated Percentage of Flow to Lagoon	Estimated Flow to Lagoon (gpd)	Effluent Concentration of Nitrogen (mg/L)	Depth to GW	Soil Type	Leach Field Reduction	Effluent Conc at the Lagoon (mg/L)	Nitrogen Load to the Lagoon (lb/day)
Malibu Animal Hospital -23431 PCH	500	95%	475.0	40.0	10	sand, silt & clay	20%	32.0	0.13
Malibu Adm. Center -23519 Civic Ctr Wy	4,038	60%	2,422.8	40.0	>10	sand, silt & clay	20%	32.0	0.65
Raquet Club -23847 Stuart Ranch Rd	1,500	20%	300.0	75.0	ukn.	sand, silt & clay	0%	75.0	0.19
Prudential Realty -23405 PCH	450	95%	427.5	40.0	10	mostly sand	20%	32.0	0.11
*Malibu Country Mart I^ -3835 Cross Creek Rd	8,400	95%	7,980.0	80.0	<5	sand & silt	0%	80.0	5.33
*Malibu Country Mart II^ 23410 Civic Ctr Wy	6,300	95%	5,985.0	80.0	<5	sand & silt	0%	80.0	4.00
*Malibu Country Mart III^ -3900 Cross Creek Rd	3,400	95%	3,230.0	80.0	<5	mostly sand & silt	0%	80.0	2.16
Malibu Shell^^ -23387 PCH	300	95%	285.0	4.2	5 to 10	mostly sand	20%	3.4	0.01
Malibu Prof. Arts Bldg -23440 Civic Ctr Wy	450	60%	270.0	40.0	10	sand, silt & clay	10%	36.0	0.08
Malibu Lumber ^^ -23479 PCH	8,500	60%	5,100.0	5.7	5 to 10	fill, sand, silt & clay	20%	4.6	0.19
*Mira Mar Properties -23805-23815 Stuart Ranch Rd	3,200	20%	640.0	40.0	>10	sand, silt & clay	0%	40.0	0.21
J & P Limited -3806 Cross Creek Rd	500	95%	475.0	40.0	10	mostly sand	20%	32.0	0.13
So. Calif. Edison	400	95%	380.0	40.0		mostly sand	20%	32.0	0.10
Verizon South, Inc. -3705 Cross Creek Rd	400	95%	380.0	40.0		sand & silt	20%	32.0	0.10
Mariposa Land Company, LLC -3728 Cross Creek Rd	400	95%	380.0	40.0		mostly sand	20%	32.0	0.10
Malibu Creek Plaza/Malibu Village^^ -PCH &Cross Creek	11,000	95%	10,450.0	3.0	<5	mostly sand	10%	2.7	0.24
Commercial - 16 Business Facilities	49,738		39,180.3						13.72
Residential 2 homes	800	95%	760.0	45.0				45.0	0.29
Total									14.0

^Expected high level of BOD and Total Nitrogen, but Total Nitrogen reduced by weekly pumping of septic tanks

^^these facilities have package advanced OWTS
*Seepage Pit Disposal or Failed Leachfield = 0% soil treatment

Sector 4	Discharge (gpd)	Estimated Percentage of Flow to Lagoon	Estimated Flow to Lagoon (gpd)	Effluent Concentration of Nitrogen (mg/L)	Depth to GW	Soil Type	Leach Field Reduction	Effluent Conc at the Lagoon (mg/L)	Nitrogen Load to the Lagoon (lb/day)
Malibu Rd., LLC -23676-23712 Malibu Rd	400	1%	4.0	40.0	<10	sand, silt & clay	20%	32.0	0.00
Morton-Gerson -23730 Malibu Rd	400	1%	4.0	40.0	<10	sand, silt & clay	20%	32.0	0.00
L.A. Co. Fire Station #88^^ -23720 Malibu Rd	540	1%	5.4	30.0	<10	sand, silt & clay	20%	24.0	0.00
Lisa Krasnoff -23655 Malibu Colony Rd	400	1%	4.0	40.0	<10	sand & silt	0%	40.0	0.00
Mesa, LLC 23915 PCH	400	1%	4.0	40.0	unknown	unknown	0%	40.0	0.00
Commercial - 5 Business Facilities	2,140		21.4						0.01
73 of 180 Res.@50% Flow to Lagoon	25,900	45%	11,655.0	45.0				45.0	4.38
107 of 180 Res.@20%Flow toLagoon	39,900	1%	399.0	45.0				45.0	0.15
Total									4.53

*187 homes were counted in Sector 4 with a total calculated flow of 65600 gpd
^^these facilities have package advanced OWTS

Sector 5	Discharge (gpd)	Estimated Percentage of Flow to Lagoon	Estimated Flow to Lagoon (gpd)	Effluent Concentration of Nitrogen (mg/L)	Depth to GW	Soil Type	Leach Field Reduction	Effluent Conc at the Lagoon (mg/L)	Nitrogen Load to the Lagoon (lb/day)
Surfrider Co. Beach -23050 PCH	3,188	10%	318.8	40.0	>10	mostly beach sand	0%	40.0	0.11
Malibu Pier State Park^^ -23000 PCH	3,000	1%	30.0	11.7	<10	mostly sand	10%	10.5	0.00
Malibu Shores Motel^ -23033 PCH	2,843	1%	28.4	60.0	10	sand & silt	10%	54.0	0.01
Malibu Beach Inn^^ -22878 PCH	2,843	1%	28.4	31.9	<10	mostly sand	0%	31.9	0.01
Jack-in-the-Box^^ -23017 PCH	4,500	1%	45.0	26.26	>10	fill, sand & silt	20%	21.0	0.01
Malibu Plaza 22917 PCH	1,500	1%	15.0	40.0	~10	fill, sand & silt	0%	40.0	0.01
Malibu Inn & Restaurant^ 22969 PCH	6,200	1%	62.0	110.0	~10	sand, silt & clay	0%	110.0	0.06
Surfshack/Fish Grill -22935 PCH	400	1%	4.0	80.0	~10	fill, sand & silt	0%	80.0	0.00
Spic & Span Cleaners/Chabad -22941 PCH	400	1%	4.0	40.0	~10	fill, sand & silt	0%	40.0	0.00
Commercial - 9 Business Facilities	24,074		527.7						0.20
Residential 23 homes	10,800	1%	648.0	45.0				45.0	0.24
Total									0.45

^Effluent assumed to have high TN because of low septic tank retention time
^^these facilities have package advanced OWTS

Study Area	Discharge (gpd)	Estimated Percentage of Flow to Lagoon	Estimated Flow to Lagoon (gpd)	Effluent Concentration of Nitrogen (mg/L)	Depth to GW	Soil Type	Leach Field Reduction	Effluent Conc at the Lagoon (mg/L)	Nitrogen Load to the Lagoon (lb/day)
Commercial	128,469		47,317.9						16.25
Residential	126,300		51,907.0						19.49
Total	254,769		99,224.9						35.74

DRAFT AUG 5 2009

Technical Memorandum #4:
Nitrogen Loads from Wastewater Flowing to Malibu Lagoon are a Significant Source of Impairment to Aquatic Life

Attachment 4-1

Nitrogen Mass Loading for Malibu Lagoon and Review Summary of Previous Studies on Mass Loadings from OWDS to the Lagoon

C.P. Lai, Ph.D., P.E.

This memorandum summarizes the findings of previous studies on the mass loadings of nitrogen to Malibu Lagoon from on-site wastewater disposal systems (OWDS). Using recent data, staff then estimated the nitrogen loading into Malibu Lagoon based on previous numerical modeling results and a spread sheet model. Finally, staff estimated the nitrogen concentration in Lagoon water resulting from this mass loading by using a continuous stirred tank reactor (CSTR) mass balance model.

1.0 Briefing of Previous Studies

Three previous studies about the subject topics have been reviewed and their estimates of mass loadings of nitrogen at the edge of the Lagoon are summarized as follows:

1.1 Stone Report
(Groundwater-Flow and Solute Transport Modeling as Appendix 3 of the Final Report "Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu, California", August 2004)

A numerical model was used to simulate groundwater flow and solute transport in the alluvium deposited along Malibu Creek and Lagoon near the Malibu Civic Center area. The groundwater flow model used in this study is the USGS MODFLOW model and the solute transport model is the USEPA MT3D groundwater transport model. The model is limited by the amount of data that was used to build, calibrate, and verify the model.

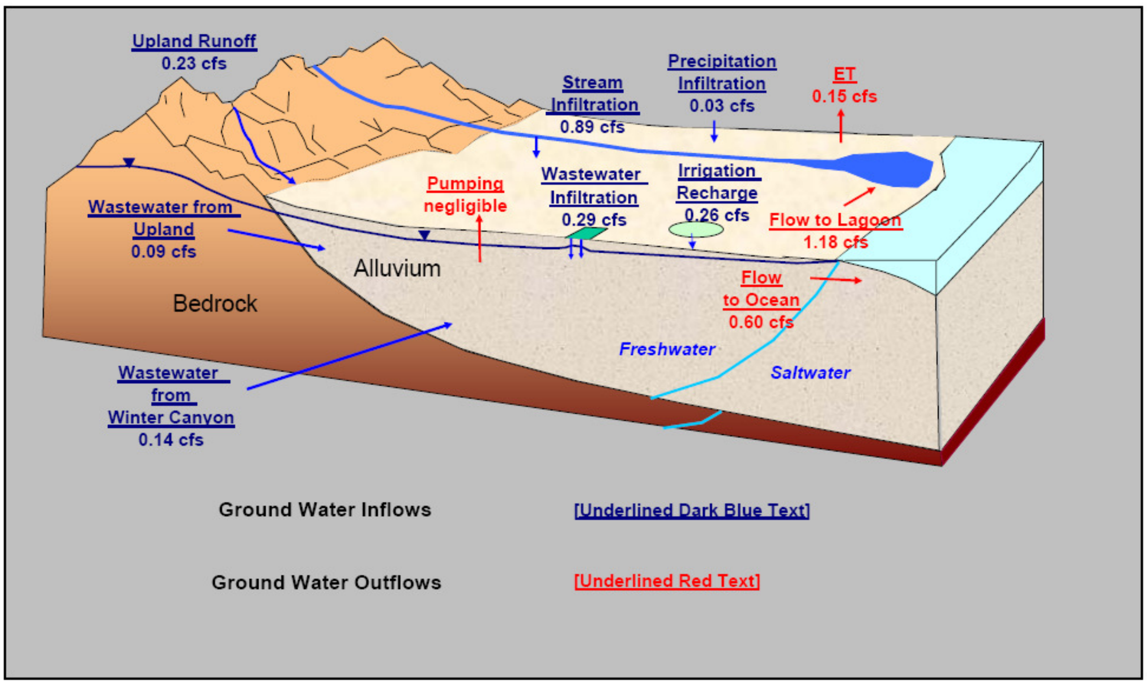
The purposes for constructing a model for the Malibu Civic Center area were to develop a water budget, to determine directions of groundwater flow, to identify which parts of the study area contribute groundwater flow to the beaches and to Malibu Lagoon, to estimate how long it takes groundwater from various parts of the study area to reach the beaches and Malibu Lagoon, and to estimate how much nitrogen is transported by the groundwater from OWDS to the Lagoon and to the ocean. No attempt was made in this model to estimate the mass loading for bacteria.

Results from the flow modeling were used to evaluate directions of groundwater flow, groundwater travel times in the flow system, and the contributing area for the Lagoon and ocean. The transport simulation was run for the period from 1930 through 2090, for a total of 160 years.

The total amount of wastewater disposal assumed as input for the model is approximately 0.52 cubic feet per second (cfs). Commercial wastewater disposal is estimated to be about 0.115 cfs. Source concentrations of nitrogen from OWDS were assumed to be 20 mg/l from domestic wastewater disposal systems and 50 mg/l from commercial systems.

The total average annual inflow to the alluvial groundwater flow system was estimated and is presented in Figure 1 below. The estimated total annual inflow to the alluvial groundwater flow system is approximately 1.93 cfs. The estimated total annual outflow is also 1.93 cfs, which includes 1.18 cfs to Malibu Lagoon, 0.60 cfs to the Pacific Ocean and 0.15 cfs for evapotranspiration.

Figure 1 Average Annual Groundwater Budget for the Malibu Alluvium



Transport model simulations were run with four steady-state hydraulic stresses, which represent changing source loadings over different time periods, for un-breached and breached Lagoon conditions in order to estimate nitrogen loadings to the ocean and Lagoon from OWDS. Depending upon the assumptions of nitrate degradation, the calculated maximum nitrogen loading to the Lagoon resulting from OWDS ranges from 31 lbs/day (un-breached Lagoon with no degradation) to 11 lbs/day (breached Lagoon with a 2-year half life). The calculated nitrogen mass loading rates to the Malibu Lagoon and the ocean under the breached Lagoon condition are shown in Figure 2. Figure 2 shows that the model predicted the nitrate loading, which is an approximation of the total nitrogen loading.

Additionally, the study modeled groundwater movement to determine the time of travel to Malibu Creek, Malibu Lagoon, the surf zone, and the ocean. Some areas had times of travel as short as six months and others as long as 50 years.

Figure 2 Calculated Nitrogen Loading Rates to the Malibu Lagoon and the Ocean under the Breached Condition

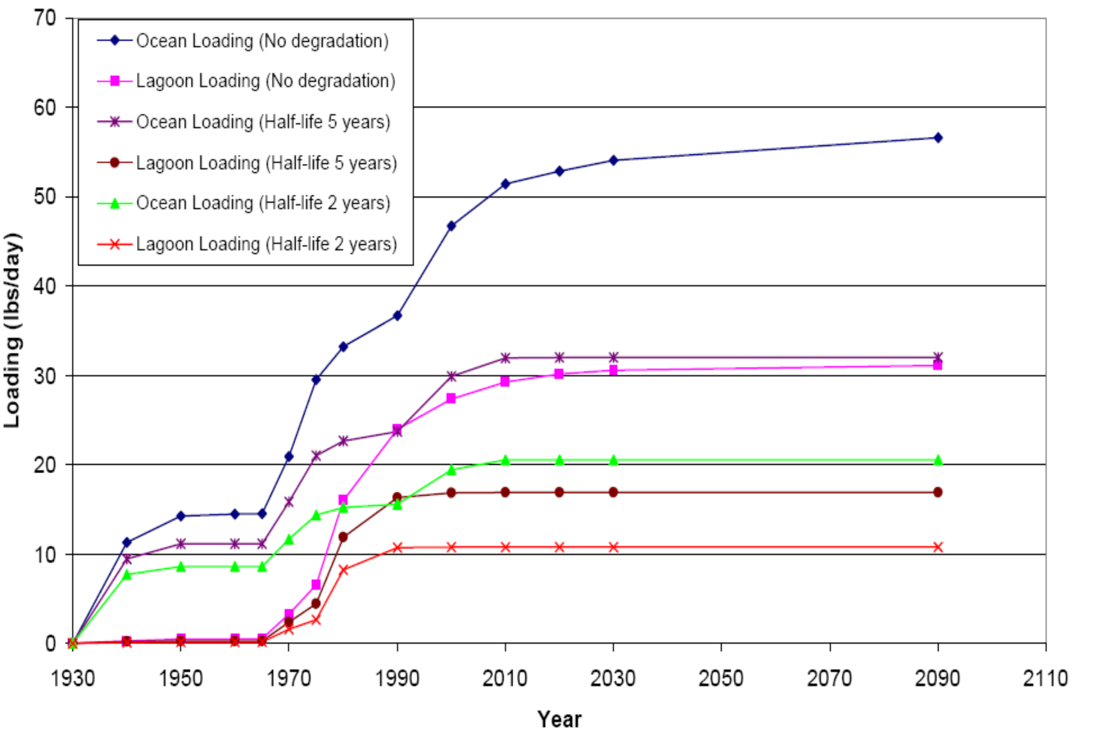


Figure 30 - Nitrate loading rates to the ocean and lagoon under breached lagoon conditions, with no degradation, five-year half life and two-year half life.

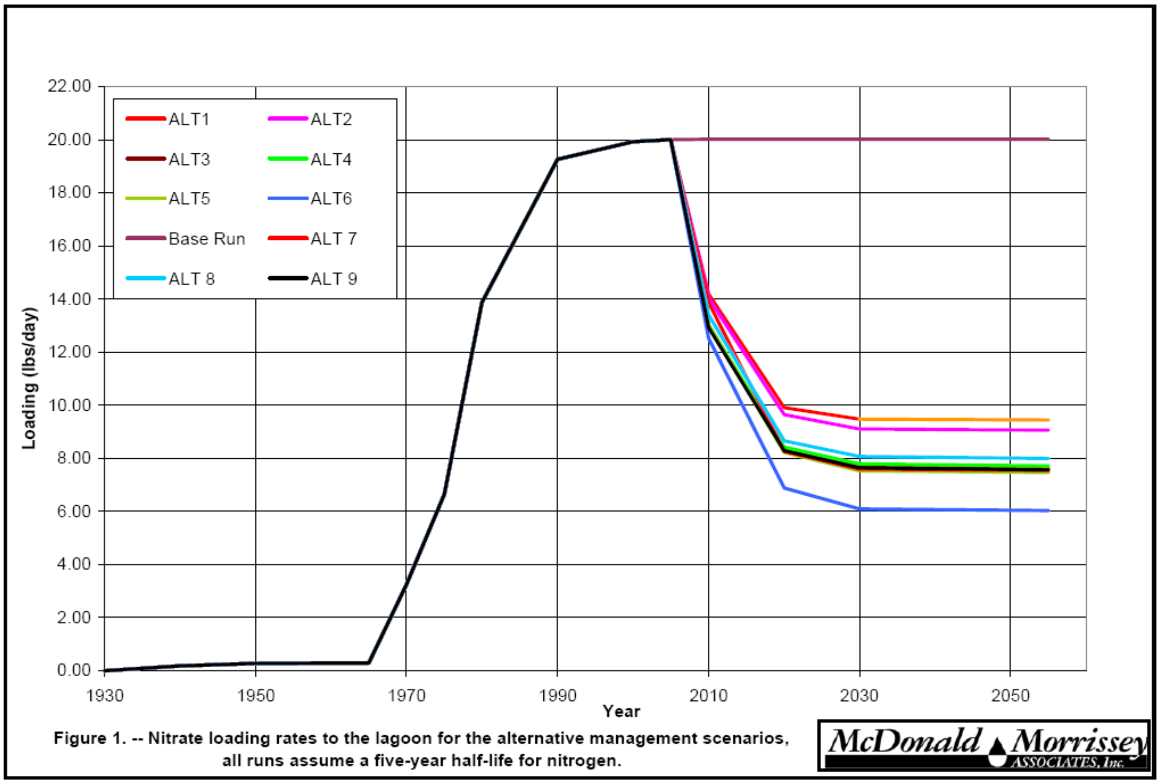
1.2. Questa Report

(Groundwater Modeling Report as Appendix D of the Final Report "Civic Center Integrated Water Quality Management Feasibility Study for City of Malibu", April 2005)

The three-dimensional groundwater flow and solute transport model developed for the Risk Assessment study (the Stone Report) was refined by McDonald Morrissey Associates to assess the potential water quality implications of various combinations of wastewater collection, treatment and dispersal options. Nine options were evaluated along with a baseline condition. Estimated wastewater flows from future development, as well as existing wastewater flows, were considered in the analysis. The model results of nitrogen mass loadings into the Malibu Lagoon for each wastewater management alternative, including the existing condition, are shown in Figure 3.

The nitrogen load at the present condition was estimated to be approximately 20 lbs/day. This result is slightly greater than the result obtained in the Stone Report (17 lbs/day) because additional loading from commercial OWDS was included. Figure 3 shows that the model predicted the nitrate loading, which is an approximation of the total nitrogen loading.

Figure 3 Calculated Nitrogen Loading Rates to the Malibu Lagoon for the Alternative



Management Scenarios

1.3 Tetra Tech Report
(Nutrient and Coliform Modeling for the Malibu Creek Watershed TMDL Studies, December 2002)

The TMDL modeling report estimated that nitrogen loading from residential OWDS is 59.2 milligram/liter (mg/l) with 274 gallons per day (gpd) average effluent flow rate. It also assumed that there are two billion coliform counts per person per day discharged into OWDS, and an average population of 3.4 persons per household.

For "normal" OWDS, the TMDL report assumed 100% of the bacteria load is removed prior to reaching surface water bodies, and that 50% of the nitrogen loading reaches the surface water (TetraTech, 2002). For the "failed" OWDS, it was assumed that 40% of the bacteria reaches the Lagoon and 50% of the nitrogen reaches the Lagoon. For "short circuited" systems, 87% of the nitrogen loads and 20% of the bacteria loads were assumed to enter the Lagoon.

Based on the above assumptions, TetraTech (2002) estimated the current total annual bacteria load that OWDS contribute to surface water in the Malibu Lagoon subwatershed to be 1,176,760 x 10^9 counts per year (3,224 x10^9 counts per day) for fecal coliform.

Similarly, the report estimated the current total annual nitrogen load that OWDS contribute to surface water in the Malibu Lagoon subwatershed to be 23,434 pounds per year, or 64.2 lb/day (TetraTech, 2002).

2.0 Staff Estimate of Mass Loading Rates into the Malibu Lagoon

2.1 Estimate using Questa Numerical Model Results

The Questa groundwater flow and transport modeling assumed that the unsaturated zone had a negligible effect on nitrogen species and that the tidal actions and influences had a negligible effect on the water table and solute transport. Based on local soil properties, the soil is mostly sand and less clay. As such, the assumption that infiltration flows directly into the saturated zone is reasonable. As far as tidal influences are concerned, the varied tidal level will slightly affect the local water table and will not have much of an effect on the up-gradient groundwater water elevation. Therefore, staff concludes that the model results obtained from the Questa Report can be used to estimate the nitrogen mass loading to the Malibu Lagoon using recent OWDS loading data.

From Figure 2, it can be seen that the maximum loading rate to the Malibu Lagoon for the breached Lagoon condition varies from 31 lbs/day (no degradation) to 17 lbs/day (5-year half life) depending on different nitrate degradation coefficients. To be conservative, staff assumed the breached condition and a 5-year half life for the nitrate degradation rate to estimate nitrogen mass loading to the Malibu Lagoon. The relationship of nitrogen mass loading from OWDS and mass loading entering the Lagoon from the Questa Report is presented in Figure 4. There are four loading periods shown in Figure 4 to represent general changes in rates of mass loading into the Lagoon based on changes in source loading to the groundwater system. The loading period A is the period during 1930 to 1964 in which the simulated sources were from Malibu Colony only. During loading period B from 1965 to 1974, the simulated source loading includes the additional loading from residential areas in uplands adjacent to the alluvium. The loading period C from 1975 to 1989 includes all sources in loading period B plus commercial systems in the main body of alluvium. For the loading period D from 1990 to 2009, the source loading includes all sources in the loading period C plus loading from increased commercial and wastewater disposal at the Malibu Bay Colony plant.

To estimate the current loading to the Malibu Lagoon, the flow rate and concentration of wastewater from OWDS for commercial and residential areas from 2008-2009 were used to calculate the mass loading from OWDS to groundwater in the study area and then, based on the relationship for the loading period D as shown in Figure 4, to estimate the mass loading of nitrogen to the Malibu Lagoon. The resulting estimate of nitrogen mass loading into the Lagoon is 28.7 lbs/day based on mass loading from OWDS of 89.7 lbs/day as shown in Table 1.

2.2 Estimate using Spread Sheet Model

Since there are no numerical model input data available, the estimate of mass loading into the Lagoon assumes that the relationship between mass loading from OWDS and mass loading to the Lagoon is linear and the ratio of mass loading of 0.32 obtained from the Questa Report was used. However, the relationship between mass loading from OWDS and mass loading into the Lagoon may not be linear because the increased mass loading from OWDS could contribute more mass loading into the Lagoon due to the limited nitrogen capacity of groundwater during long term discharge and the effect of local groundwater flow net patterns. As such, Regional Board staff in the Groundwater Permitting Unit used a spread sheet model to estimate the mass loading entering the Lagoon based on local geotechnical data, hydraulic conductivity and groundwater flow net patterns. The estimate of mass loading into the Lagoon based on this spread sheet model is ~~39.4~~ **35.7** lbs/day resulting from a mass loading from OWDS of 89.7 lbs/day.

The comparisons of the three previous modeling results and staff estimates of nitrogen mass loading to the Malibu Lagoon using a numerical model and a spreadsheet model are presented in Table 1.

2.3 Evaluation of Nitrogen Mass Loadings into the Lagoon using a Mass Balance Model

To evaluate which estimate of mass loading to the Lagoon presented in Table 1 is the best fit with actual conditions and to understand the effect of mass loading from OWDS to the Malibu Lagoon on nitrogen concentrations in Lagoon water, staff used a continuous stirred tank reactor (CSTR) mass balance model to estimate the resulting concentration due to the mass loading. The CSTR model results for different mass loadings are presented in Figure 5. The results are compared with actual Lagoon nitrogen concentration data. It can be seen from Figure 5 that the predicted nitrogen concentration in the Lagoon due to a mass loading entering the Lagoon of 20 lbs/day (as predicted by the Questa Report) is a good comparison with the average nitrogen concentration of 1.4 mg/L for receiving water data collected by the Tapia wastewater treatment plant from 1995-1999. In addition, the predicted nitrogen concentration due to the load allocations for OWDS developed in the TMDL of 6 lbs/day is less than the nitrogen numeric target of 1.0 mg/L. The maximum of nitrogen mass loading into the Lagoon to maintain the nitrogen numeric target of 1.0 mg/L is about 13 lbs/day.

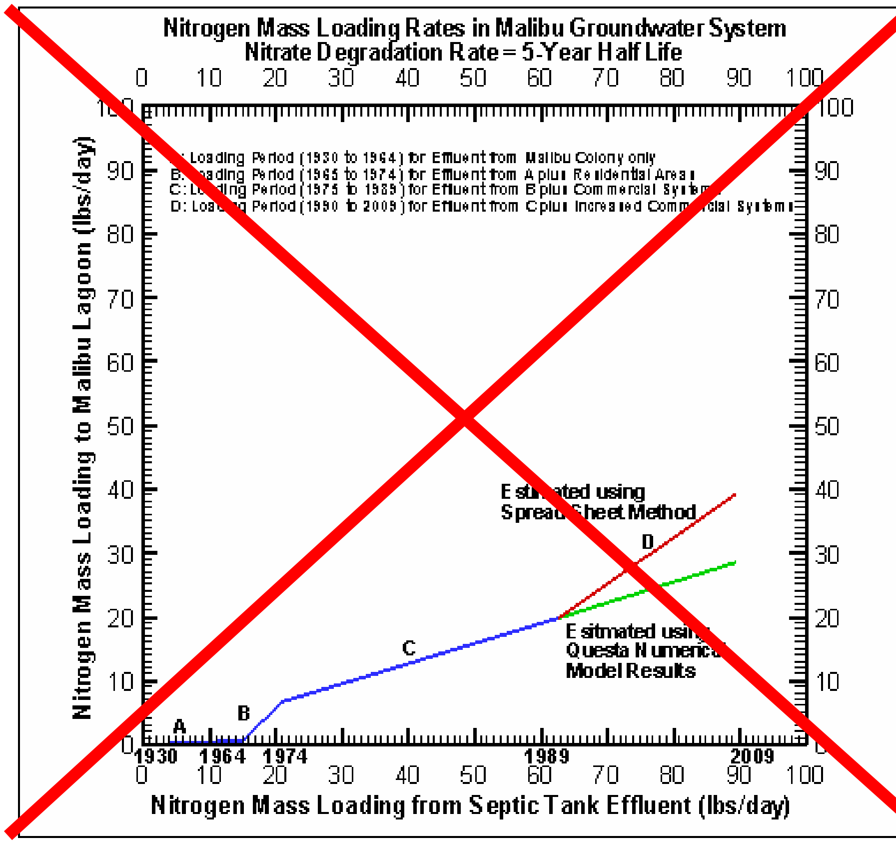
Staff estimates that the current mass loading into the Lagoon from OWDS may vary from 29 lbs/day to 36 lbs/day based on the predicted nitrogen concentrations in the Lagoon water and measured Lagoon nitrogen concentrations for 2002-2003 data (SCCWRP Technical Report 441) as shown in Figure 5. The current estimate of mass loading into the Lagoon of 35.7 lb/day using the spread sheet method would produce a nitrogen concentration in the Lagoon water of 3.0 mg/L and the current estimate of mass loading of 28.7 lb/day using the Questa numerical model results would cause the nitrogen concentration in the Lagoon water to be 2.4 mg/L. According to the measured data during 1995-1999 and 2002-2003, the nitrogen concentration in the Lagoon water is increasing. As such, the resulting nitrogen concentration of 3.0 mg/L for 2008-2009 falls within the trend of measured data from 1995 to 2003. Thus, the mass loading into the Lagoon of 35.7 lb/day is considered to be an appropriate and reasonable estimate.

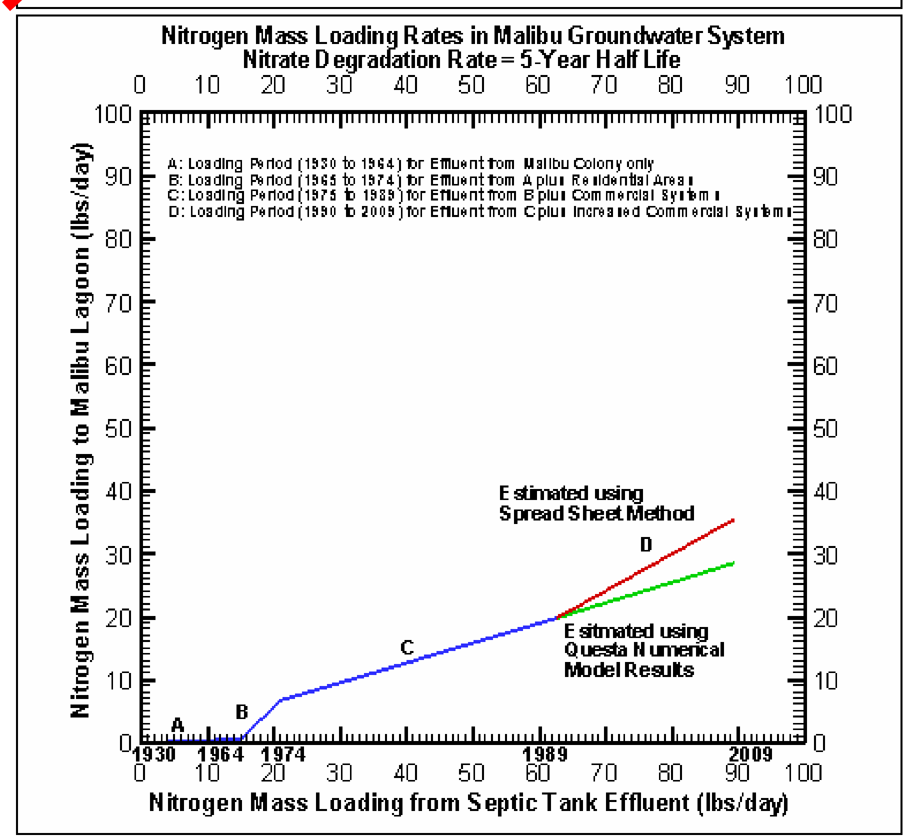
In summary, staff finds that the previous model developed by McDonald Morrissey Associates as presented in the Questa Report was calibrated with measured nitrate data and its modeling results can be used and have been used in this memo to estimate current nitrogen mass loading into the Lagoon. The spreadsheet model also provides a reasonable estimate of current mass loading to the Lagoon. By comparing the results of these two models with measured nitrogen concentration data in the Lagoon, staff estimates that ~~30-40~~ **29-36** lbs/day of nitrogen are loaded to the lagoon, which exceeds the TMDL load allocation and results in exceedances of the TMDL numeric target.

3.0 References

1. "Risk Assessment of Decentralized Wastewater Treatment Systems in High Priority Areas in the City of Malibu, California", Final Report, prepared for Santa Monica Bay Restoration Commission, prepared by Stone Environmental, Inc., August 30, 2004.
2. "Ground-Water Flow and Solute Transport Modeling, Malibu, California", prepared for Santa Monica Bay Restoration Project, prepared by McDonald Morrissey Associates Inc., July 28, 2004.
3. "Malibu Civic Center Integrated Water Quality Management Feasibility Study", prepared for City of Malibu, prepared by Questa Engineering Corporation, April 28, 2005.
4. "Groundwater Modeling Report in the Appendix D of Malibu Civic Integrated Water Quality Management Feasibility Study", prepared by McDonald Morrissey Associates, Inc., April 26, 2005.
5. "Total Maximum Daily Loads for Nutrients Malibu Creek Watershed", United States Environmental Protection Agency, Region 9, 2003.
6. "A Steady-State Groundwater Flow Model for the Proposed Malibu-La Paz Ranch Development", prepared for Sterling Capitol, prepared by Furgo West, Inc., March 2005.
7. "Final Malibu Lagoon Restoration and Enhancement Plan", prepared for the California State Coastal Conservancy & California State Department of Parks and Recreation, prepared by Moffatt & Nichol, June 17, 2005.
8. "Summary of Stormwater Management and Water Quality Improvements for Lower Malibu Creek and Lagoon", prepared for City of Malibu, prepared by RMC, March 26, 2008.
9. "Lower Malibu Creek and Lagoon Resource Enhancement and Management ", Final Report to the California State Coastal Conservancy, prepared by Richard F. Ambrose and Antony R. Orme, University of California, Los Angeles, May 2000.
10. "Malibu Wetland Feasibility Study", prepared for Malibu Coastal Land Conservation, prepared by Huffman and Carpenter, Inc., August 2000.
11. "Sediments as a Non-Point Source of Nutrients to Malibu Lagoon, California, USA", Southern California Coastal Water Resources Project (SCCWRP) Technical Report 441, October 2004.
12. Las Virgenes Municipal Water District (LVMWD),Tapia Water Reclamation Facilities, Malibu Creek Monitoring Program, 1995-1999 Annual Report, NPDES Permit No. CA0056014.

Figure 4 Relationship of nitrogen mass loading from OWDS and mass loading into the Lagoon





DRAFT AUG 5 2009

Table 1 Comparisons of nitrogen mass loading to the Malibu Lagoon for three previous studies and staff estimates

	Stone Report (2004)[b]	Questa Report (2005)[b]	Tetra Tech Report (2003)[c]	Staff Estimate Using Spread Sheet Method[d]	Staff Estimate Using Numerical Model Method[e]
1.Wastewater Flow Rate from Commercial OWDS (gal/day)	62166	100000	75000	128469	128469
2.Concentration in Commercial Wastewater (mg/L)	50	50	59.2	3 - 110	3 – 110
3.Mass Loading from Commercial OWDS (lbs/day)	25.94	41.73	37.05	42.3	42.3
4.Wastewater Flow Rate from Residential OWDS (gal/day)	126121	126121	54800	126300	126300
5.Concentration in Residential Wastewater (mg/L)	20	20	59.2	45	45
6.Mass Loading from Residential OWDS (lbs/day)	21.05	21.05	27.07	47.4	47.4
7.Mass Loading from OWDS (lbs/day)	46.99	62.78	64.12	89.7	89.7
8.Ratio of Mass Loading[a]	0.36	0.32	0.50	0.40	0.32
9.Mass Loading to Malibu Lagoon (lbs/day)	17	20	32	35.7	28.7

Note: [a] the ratio of mass loading entering Malibu Lagoon versus mass loading from OWDS, i.e., value of row 9 divided by value of row 7.

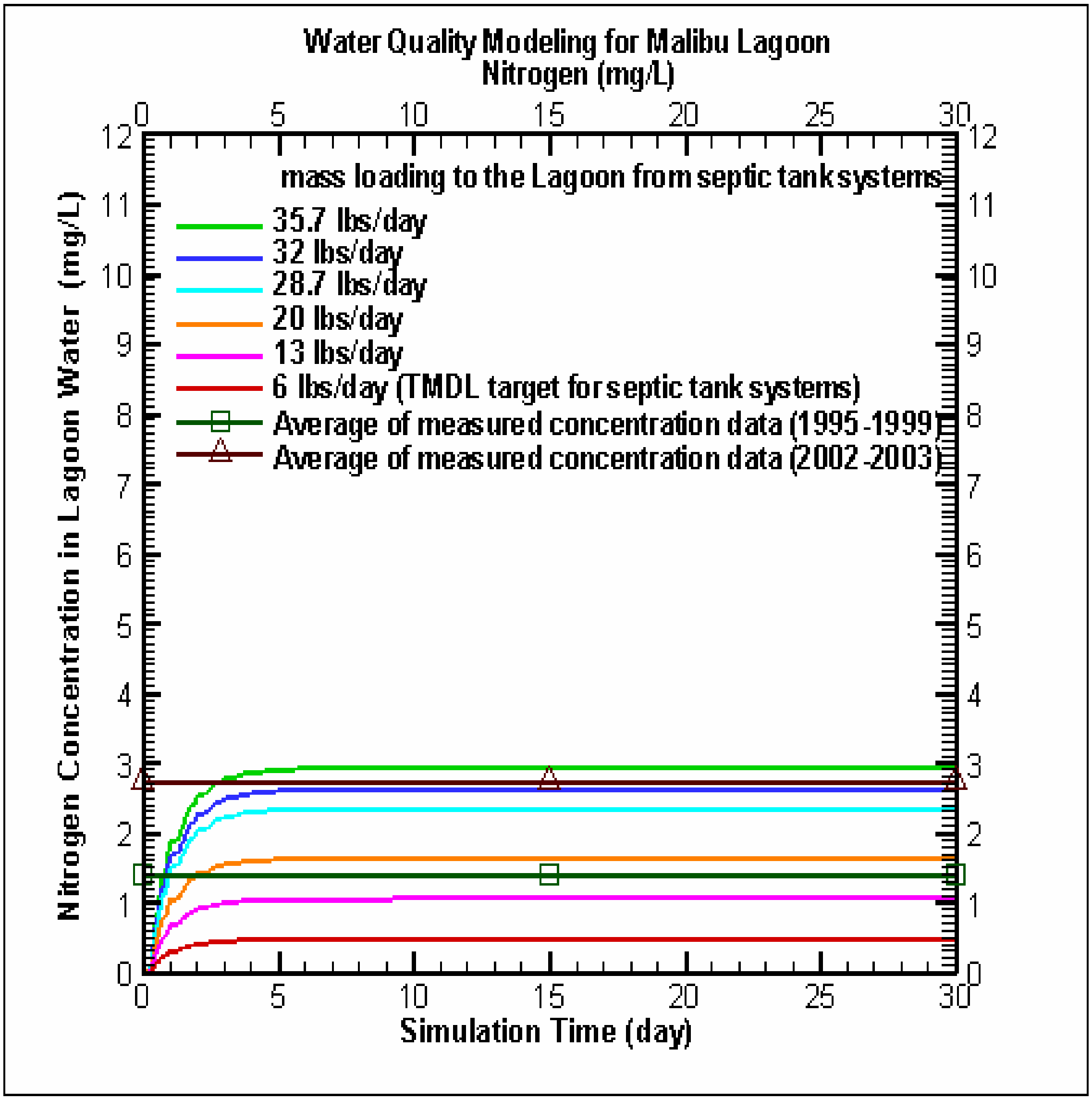
[b] the nitrogen loads were assumed to be mostly nitrate in the OWDS and the model only simulated the nitrate in the Stone and Questa Modeling Reports.

[c] 50 percent of nitrogen loads from the OWDS were assumed to enter the Malibu Lagoon.

[d] the nitrogen mass loading from OWDS was estimated based on the commercial load from each OWDS and the residential load with an average concentration of 45 mg/L for OWDS. Staff estimated the nitrogen mass loading to Malibu Lagoon by using the spread sheet method.

[e] the nitrogen mass loading based on the commercial load from each OWDS and the residential load with an average concentration of 45 mg/L from OWDS were used in the model. Staff estimated the nitrogen mass loading to Malibu Lagoon by using Questa numerical model results.

Figure 5 Nitrogen concentrations in Lagoon water resulting from different mass loadings entering the Lagoon



DRAFT AUG 5 2009